United States
Department of
Agriculture

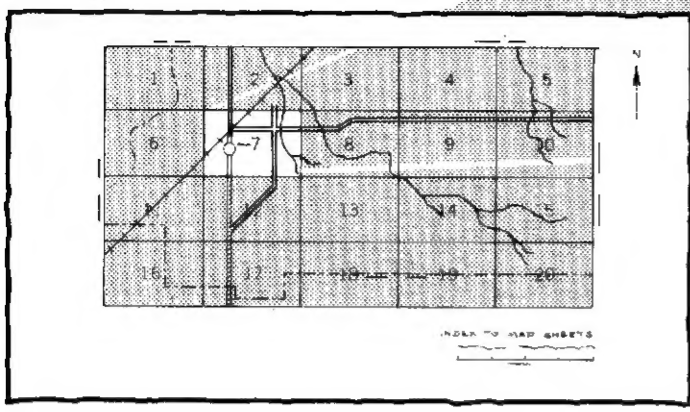
Soil
Conservation
Service

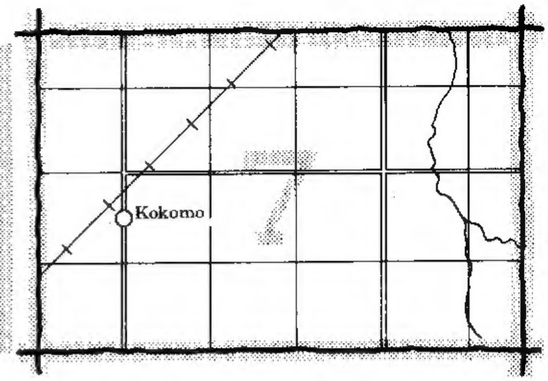
In cooperation with
University of Nebraska,
Conservation and
Survey Division

Soil Survey of Johnson County, Nebraska

HOW TO USE

1. Locate your area of interest on the "Index to Map Sheets."





2. Note the number of the map sheet and turn to that sheet.

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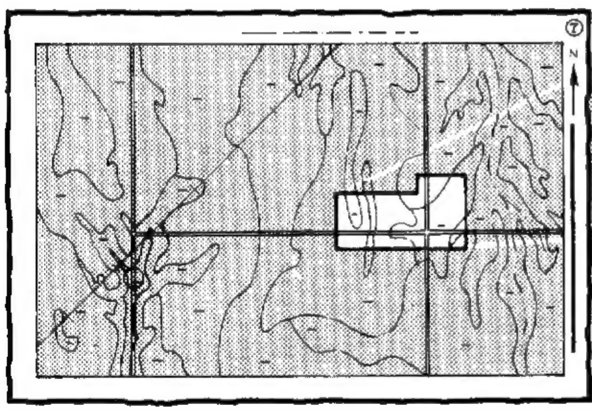
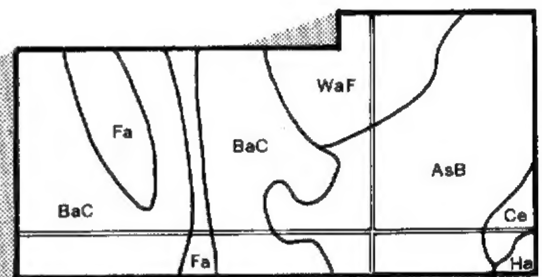
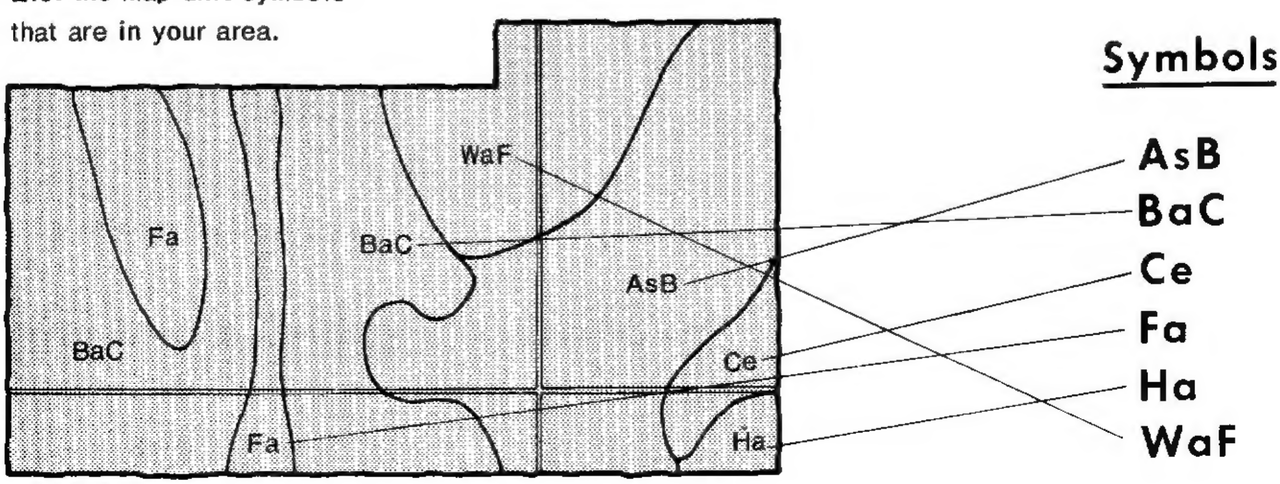


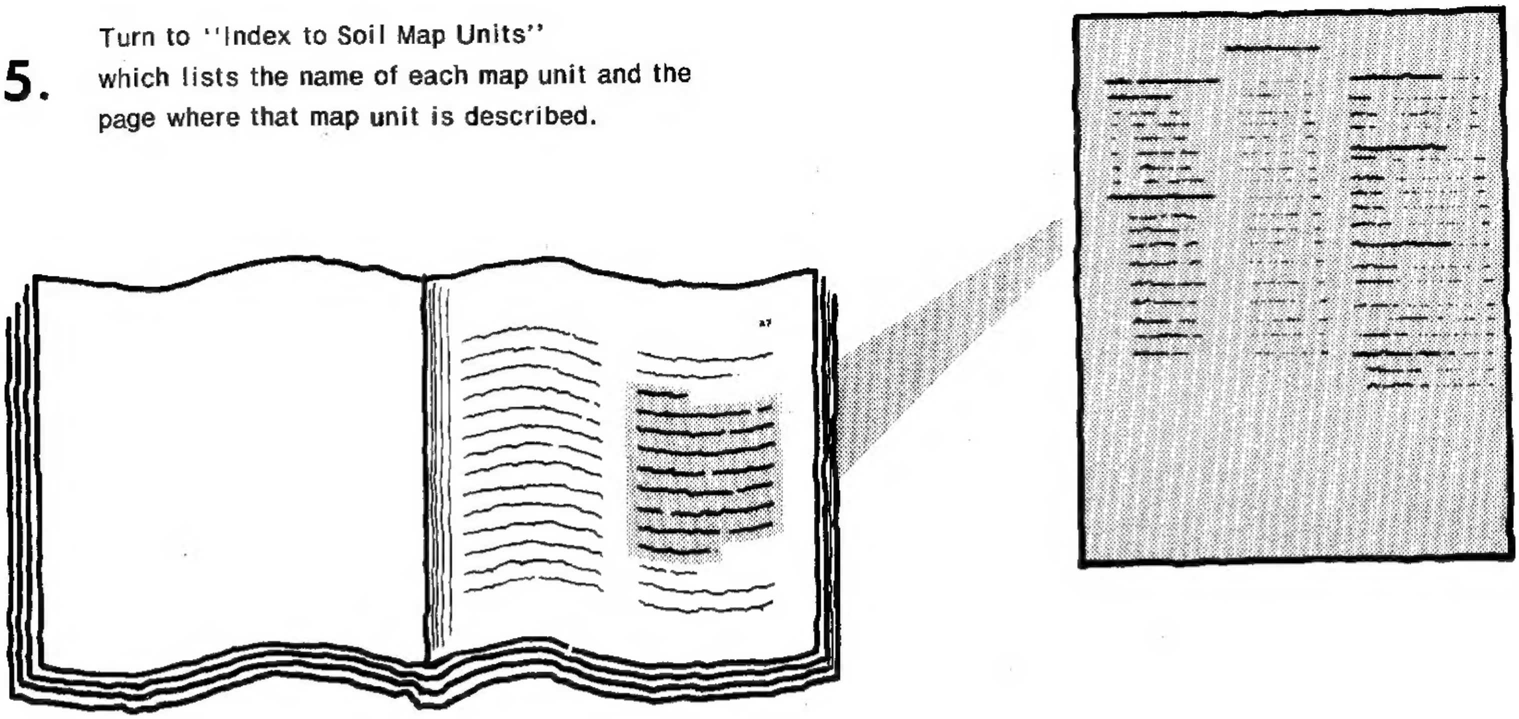


4. List the map unit symbols that are in your area.

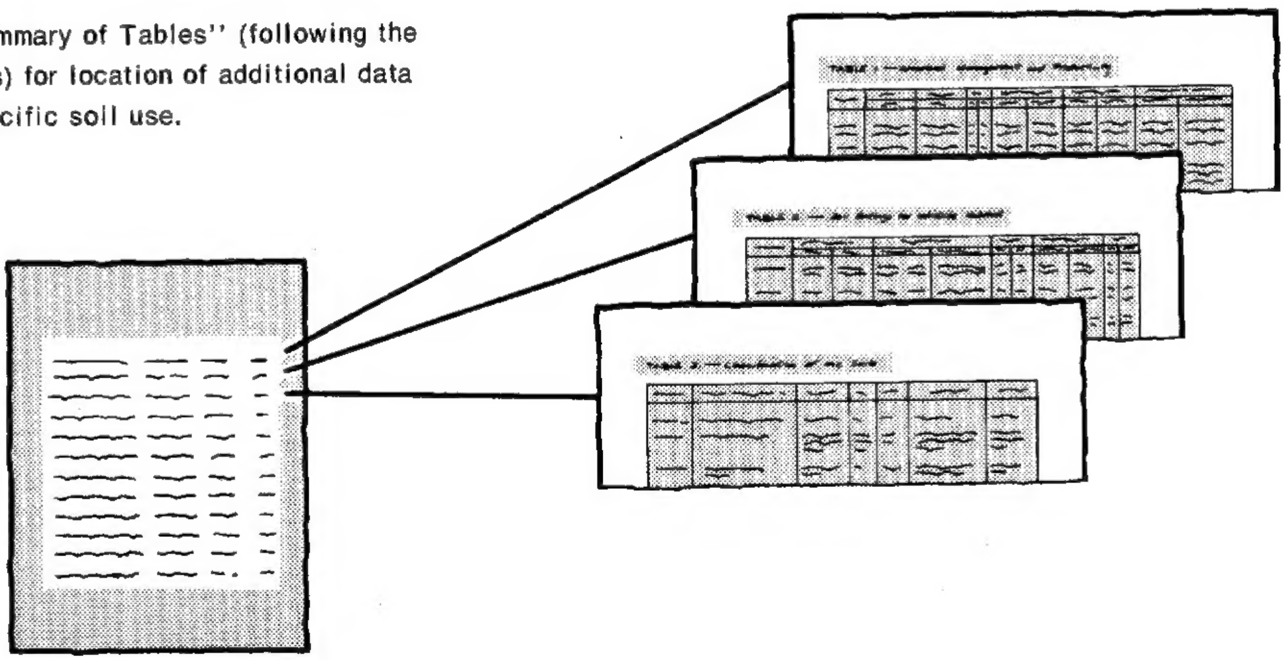


THIS SOIL SURVEY

5. Turn to "Index to Soil Map Units" which lists the name of each map unit and the page where that map unit is described.



6. See "Summary of Tables" (following the Contents) for location of additional data on a specific soil use.



7. Consult "Contents" for parts of the publication that will meet your specific needs. This survey contains useful information for farmers or ranchers, foresters or agronomists; for planners, community decision makers, engineers, developers, builders, or homebuyers; for conservationists, recreationists, teachers, or students; to specialists in wildlife management, waste disposal, or pollution control.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other federal agencies, state agencies including the Agricultural Experiment Stations, and local agencies. The Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, or age.

Major fieldwork for this soil survey was completed in 1983. Soil names and descriptions were approved in 1984. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1984. This survey was made cooperatively by the Soil Conservation Service and the University of Nebraska, Conservation and Survey Division. It is part of the technical assistance furnished to the Nemaha Natural Resources District. The Johnson County Board of Commissioners and the Nemaha Natural Resources District provided financial assistance for the survey.

Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the detail of mapping. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger scale.

Cover: Terraces, a grassed waterway, and contour farming on a Wymore soil. These measures help to control water erosion.

Contents

Soil Series

Issued September 1986

Index to Map Units

Summary of Tables

Foreword

This soil survey contains information that can be used in land-planning programs in Johnson County. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

This soil survey is designed for many different users. Farmers, ranchers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to ensure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Soil Conservation Service or the Cooperative Extension Service.

Sherman L. Lewis
State Conservationist
Soil Conservation Service

Soil Survey of Johnson County, Nebraska

By Howard E. Sautter, Soil Conservation Service, and Donald E. Ulrich,
University of Nebraska, Conservation and Survey Division

United States Department of Agriculture, Soil Conservation Service,
in cooperation with
University of Nebraska, Conservation and Survey Division

Johnson County is in the southeastern part of Nebraska (fig. 1). It is 18 miles north to south and 21 miles east to west. It has an area of 241,101 acres. Tecumseh is the county seat. The courthouse in Tecumseh is in the National Register of Historic Places.

Johnson County is part of a dissected glacial plain. Relief ranges from nearly level to very steep. The topography consists of extensive uplands and numerous strips of bottom lands. Most of the county is a succession of rounded ridges, intervening hillsides, and entrenched drainageways. The largest valley is that of the North Fork of the Big Nemaha River.

The climate is continental, and the temperature and precipitation vary greatly from season to season. The climate is suitable for growing common staple crops and grasses.

According to the Nebraska Conservation Needs Inventory, about 61 percent of the acreage in the county is cropland, 17 percent is pasture, 13 percent is range, and 3 percent is woodland. The rest is used for nonfarm purposes.

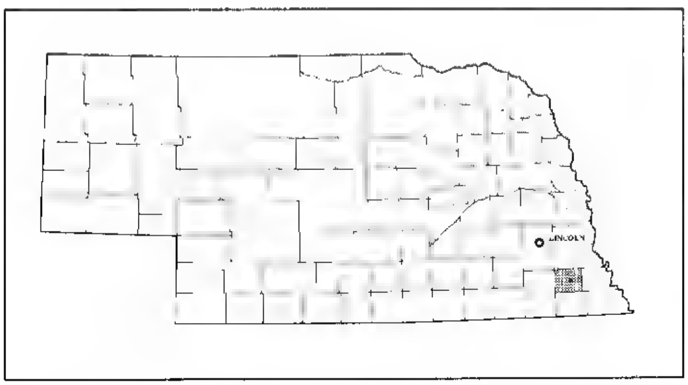


Figure 1.—Location of Johnson County in Nebraska.

Agriculture is the main economic enterprise in Johnson County. Most farms are of the cash-grain or diversified grain-livestock type. The principal crops are grain sorghum, corn, soybeans, wheat, and alfalfa hay. Cattle and hogs are commonly raised on most farms, and some farms specialize in raising specific breeds of livestock. A few horses are kept on some farms.

The major soils on uplands formed in loess and glacial material. The principal hazard is water erosion. The other management concerns are conserving water and maintaining soil structure and fertility.

The soils in the valleys formed in alluvium. On some of these soils, wetness is a problem and flooding is an occasional hazard. The management concerns are maintaining soil structure and improving drainage.

The soils in Johnson County are mainly loamy and clayey, and they consist mostly of silt-sized and clay-sized particles. Very few of the soils formed in sandy material. The soils range from deep to shallow, from well drained to very poorly drained, and from nearly level to very steep.

This survey updates the soil survey of Johnson County published in 1924 (*7*). It gives additional information and has large maps, which show the soils in greater detail.

General Nature of the County

This section provides general information concerning Johnson County. It describes climate; history and

development; physiography, relief, and drainage; geology; water supply; and trends in agriculture.

Climate

Prepared by the National Climatic Center, Asheville, North Carolina.

The consistent pattern of climate in Johnson County is one of cold winters and long, hot summers. Heavy rains occur mainly in spring and early in summer, when moist air from the Gulf of Mexico interacts with drier continental air. The annual rainfall normally is adequate for corn, soybeans, and all grain crops.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Tecumseh, Nebraska, in the period 1951 to 1980. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter the average temperature is 26 degrees F, and the average daily minimum temperature is 15 degrees. The lowest temperature on record, which occurred at Tecumseh on January 12, 1972, is -25 degrees. In summer the average temperature is 75 degrees, and the average daily maximum temperature is 87 degrees. The highest recorded temperature, which occurred at Tecumseh on July 15, 1980, is 109 degrees.

Growing degree days are shown in table 1. They are equivalent to "heat units." During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (50 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

The total annual precipitation is 33.40 inches. Of this, 24 inches, or about 70 percent, usually falls in April through September. The growing season for most crops falls within this period. In 2 years out of 10, the rainfall in April through September is less than 18 inches. The heaviest 1-day rainfall during the period of record was 5.42 inches at Tecumseh on July 22, 1978. Thunderstorms occur on about 44 days each year. Tornadoes and severe thunderstorms occur occasionally but are local in extent and of short duration. They cause damage in scattered areas. Hailstorms occur at times during the warmer part of the year but in an irregular pattern and in only small areas.

The average seasonal snowfall is about 29 inches. The greatest snow depth at any one time during the period of record was 30 inches. On the average, 21 days of the year have at least 1 inch of snow on the ground. The number of such days varies greatly from year to year.

The average relative humidity in midafternoon is about 60 percent. Humidity is higher at night, and the average at dawn is about 80 percent. The sun shines 70 percent of the time possible in summer and 55 percent in winter. The prevailing wind is from the south-southeast. Average windspeed is highest, 13 miles per hour, in spring.

History and Development

Prior to the exploration and settlement of the West, the survey area was claimed by the Oto and Missouri Indians (*4*). On September 21, 1833, it was ceded to the United States, but the Indians retained hunting rights. On March 15, 1854, the Indians were forced to a reservation south of where Barneston, in Gage County, Nebraska, is now located.

When first surveyed, Johnson County was included in an area known as Forney County, Nebraska Territory. On March 7, 1855, Forney County was divided, and the eastern part became Nemaha County and the western part Johnson County.

The first permanent settlers came from Indiana. They arrived in the winter of 1854-55 and settled about 3 miles southeast of the present site of Tecumseh.

Tecumseh was established in 1856 at the intersection of the Nebraska City-Marysville Trail, the Brownville-Beatrice Trail, and the North Fork of the Big Nemaha River. Shortly thereafter, settlements were established in other areas of the county. These later became small towns. The livelihood of the settlers came mainly from agriculture. The county's population grew gradually in the 1860's, spurred by the Homestead Act of 1862 and an influx of former soldiers after the Civil War. In the 1870's and 1880's the railroads were built. They were responsible for a rapid growth of population and commerce.

Since the 1920's, as automobile transportation and the highway system have improved, rural residents have become less dependent on local services and supplies. The result has been a gradual decrease in the county's population and the near disappearance of some small towns. The population of the county decreased from 8,662 in 1940 to 5,285 in 1980.

U.S. Highway 136 and State Highway 41 traverse the county east and west, and State Highway 50 crosses the county north and south. Paved roads link all small communities. The Burlington Northern Railroad traverses the county from northwest to southeast, and the Missouri Pacific Railroad runs east and west along the northern edge of the county.

The economy of the county is supported mainly by farming and by small businesses, which provide local services. In addition, a food processing plant and a tankage processing plant are located in Tecumseh.

Physiography, Relief, and Drainage

Johnson County lies within the glaciated part of the Great Plains physiographic province (*3*). It is on a dissected glacial plain. Only small remnants of the original till plain remain, on the highest divides. The

gently sloping to very steep landscape formed through geologic erosion of the glacial plain. Materials have been added and modified by cycles of sedimentation, erosion, and soil formation. Erosion shaped the uplands and the continuous strips of bottom land. Uplands are the most extensive feature of the landscape. The strips of bottom land include the low-lying areas adjacent to streams where soil material was deposited.

Relief ranges from nearly level to very steep. Because of the headward advance of numerous small drainageways, the areas of nearly level uplands are small and, in places, irregular in outline. The rest of the county is a succession of ridges, strongly sloping to very steep areas, and valleys. The ridges are rounded and gently sloping. The valley bottoms are nearly level.

Long, gradual slopes on the north side of stream valleys and short, steep slopes on the south side are features of the uplands. Slopes along the large streams that border bottom lands generally are steeper than those near the crests of ridgetops. The small drainageways generally are shallow; however, in places they are sharply cut and have short, steep grades. Bottom lands range in width from a few rods along the smaller streams to about 1.5 miles along the North Fork of the Big Nemaha River.

The highest elevation is about 1,490 feet, on the upland divide in the southwest corner of the county. The lowest elevation is about 1,000 feet, along the South Fork of the Little Nemaha River in the northeastern part of the county.

Drainage is chiefly southeasterly. A number of major and minor streams are fed by many tributaries. The North Fork of the Big Nemaha River flows southeasterly across the central part of the county, and it receives about 70 percent of the surface runoff. The South Fork of the Little Nemaha River and Spring Creek, which flow northeasterly, receive most of the surface runoff from the rest of the county. The principal tributaries of the North Fork include the Middle Branch of the Big Nemaha River and Yankee, Hooker, Saunders, Silver, Deer, and Todd Creeks. Nearly all of the rivers and major creeks flow constantly.

Geology

The earth materials at the surface in Johnson County are loess, glacial material, alluvium, and shale and limestone residuum (*6*). The deep bedrock consists of the calcareous shale and limestone of the Permian and Pennsylvanian Periods.

An eroded landscape of hills and valleys formed when the bedrock material was at the surface. Then, during the ice age, this landscape was buried by glacial materials. Some of the valleys were filled with sand and gravel and some with clayey glacial material. After the ice melted, glacial deposits covered the bedrock material. In Johnson County, the dominant glacial deposits are grayish and clayey and contain many fine to coarse sand grains, some gravel and cobbles, and a few boulders. Burchard, Pawnee, Shelby, and Steinauer soils formed in areas where these deposits are at the surface.

Associated with the clayey glacial deposits are silty, sandy, loamy, and clayey materials. Malcolm soils formed in areas of grayish, coarse silty material. Dickinson soils formed in areas of loamy and sandy materials. Morrill soils formed in areas of brown or reddish brown, loamy material. Mayberry soils formed in areas of brown or reddish brown, clayey material.

The uppermost material in the county is a layer of grayish brown loess. This layer consists mostly of silt-sized particles and some clay-sized particles. Wymore soils formed in areas of loess.

Alluvium in the valleys is dominantly silty and clayey materials washed from upland slopes onto the flood plains. Most of the water-deposited materials came from the local watershed. Kennebec and Nodaway soils formed in areas of silty material. Nishna and Wabash soils formed in areas of clayey material. Zook soils formed in areas of mixed silty and clayey material.

Water Supply

In most areas of the county, good quality well water is available for use in farm households and for livestock. Large quantities suitable for use in municipalities or for irrigation are limited to certain areas.

Water for individual farms generally is obtained from perched water zones. Shallow wells, 25 to 100 feet deep, are developed in sand lenses of glacial deposits and in sandy alluvium in stream valleys. Throughout most of the county, these wells yield 1 to 10 gallons per minute with continuous pumping. They are recharged by seepage and percolation of the annual precipitation; therefore, prolonged drought may further reduce their output. In areas of shale and limestone, a water supply is difficult to develop. Wells in valley fill and springs or seeps produce some water for livestock.

Studies of ground water in Johnson County have given some information on the availability of ground water. These studies were made by the Conservation and Survey Division, University of Nebraska, in cooperation with the U.S. Geological Survey. The studies indicate that before glaciers advanced across the eastern part of Nebraska, streams had cut channels into the bedrock. The channels were later filled with glacial materials. In areas where the buried channels contain sand and gravel, wells capable of producing several hundred gallons per minute can be developed. These areas, however, are limited and not completely defined. Tecumseh obtains its water from one of these ancient, deep stream channels located north of the town. In recent years, rural water districts have developed well fields in areas where large quantities can be obtained. The water is piped to farmsteads throughout the county.

Nearly all of the well water in Johnson County is hard or very hard. The content of sulfates and iron commonly restricts some uses, but it is generally not a health hazard to people or livestock.

Ground water can be contaminated by drainage from feedlots, septic disposal systems, spilled chemicals, or other waste disposal materials. Shallow wells can be contaminated by wastes more easily than deep wells. A newly installed, domestic well can be tested for contamination.

Surface water is an important supplement to the limited ground water supply in Johnson County. Its use for livestock and recreation extends the supply of quality ground water for domestic use. Streams and ponds that are easily developed are widely used to supply water for livestock. Reservoirs have not been developed for municipal water supplies.

Trends in Agriculture

Farming has been the most important enterprise in Johnson County since the county was settled. In the early years, a large acreage was planted to orchards and to oats, barley, rye, and other small grain. These crops were produced for local use. They are now of minor importance. The kinds of crops now grown and their acreages have been fairly constant through the years. The number of farms, however, has declined, and the size of each farm has increased.

The county is expected to remain an important farming area dominated by cash-grain farms, livestock farms, or a combination of these.

In 1981, there were 650 farms in the county (*5*). The principal crops and their acreages were grain sorghum, 51,600 acres; soybeans, 30,000 acres; wheat, 25,000 acres; corn harvested mainly for grain, 17,000 acres; alfalfa hay, 12,000 acres; and oats, 3,200 acres. The principal kinds of livestock numbered 50,000 hogs and pigs, 29,600 cattle and calves, and 1,400 milk cows.

How This Survey Was Made

This survey was made to provide information about the soils in the survey area. The information includes a description of the soils and their location and a discussion of the suitability, limitations, and management of the soils for specified uses. Soil scientists observed the steepness, length, and shape of slopes; the general pattern of drainage; the kinds of crops and native plants growing on the soils; and the kinds of bedrock. They dug many holes to study the soil profile, which is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biologic activity.

The soils in the survey area occur in an orderly pattern that is related to the geology, the landforms, relief, climate, and the natural vegetation of the area. Each kind of soil is associated with a particular kind of landscape or with a segment of the landscape. By observing the soils in the survey area and relating their position to specific segments of the landscape, a soil scientist develops a concept, or model, of how the soils were formed. Thus, during mapping, this model enables the soil scientist to predict with considerable accuracy the kind of soil at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, acidity, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. The system of taxonomic classification used in the United States is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpreted the data from these analyses and tests as well as the field-observed characteristics and the soil properties in terms of expected behavior of the soils under different uses. Interpretations for all of the soils were field tested through observation of the soils in different uses under different levels of management. Some interpretations are modified to fit local conditions, and new interpretations sometimes are developed to meet local needs. Data were assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management were assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can state with a fairly high degree of probability that a given soil will have a high water table within certain depths in most years, but they cannot assure that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Map Unit Composition

A map unit delineation on a soil map represents an area dominated by one major kind of soil or an area dominated by several kinds of soil. A map unit is identified and named according to the taxonomic classification of the dominant soil or soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural objects. In common with other natural objects, they have a characteristic variability in their properties. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of soils of other taxonomic classes. Consequently, every map unit is made up of the soil or soils for which it is named and some soils that belong to other taxonomic classes. These latter soils are called inclusions or included soils.

Most inclusions have properties and behavioral patterns similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting (similar) inclusions. They may or may not be mentioned in the map unit descriptions. Other inclusions, however, have properties and behavior divergent enough to affect use or require different management. These are contrasting (dissimilar) inclusions. They generally occupy small areas and cannot be shown separately on the soil maps because of the scale used in mapping. The inclusions of contrasting soils are mentioned in the map unit descriptions. A few inclusions may not have been observed and consequently are not mentioned in the descriptions, especially where the soil pattern was so complex that it was impractical to make enough observations to identify all of the kinds of soil on the landscape.

The presence of inclusions in a map unit in no way diminishes the usefulness or accuracy of the soil data. The objective of soil mapping is not to delineate pure taxonomic classes of soils but rather to separate the landscape into segments that have similar use and management requirements. The delineation of such landscape segments on the map provides sufficient information for the development of resource plans, but onsite investigation is needed to plan for intensive uses in small areas.

Map Unit Descriptions

This section describes the map units in the survey area at two levels of detail. The general soil map units, or soil associations, are described first. Generally, they represent the soils of major extent in the survey area. Next, the detailed map units are described. They represent all the named soils in the survey area.

Some soil boundaries and soil names do not fully match those in surveys of adjoining areas that were published at an earlier date. Differences result from changes and refinements in series concepts, different slope groupings, and application of the latest soil classification system.

General Soil Map Units

The general soil map at the back of this publication shows the soil associations in this survey area. Each association has a distinctive pattern of soils, relief, and drainage. Each is a unique natural landscape. Typically, an association consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one association can occur in another but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one association differ from place to place in slope, depth, drainage, and other characteristics that affect management.

1. Pawnee-Morrill-Shelby Association

Deep, gently sloping to steep, moderately well drained and well drained, clayey and loamy soils that formed in glacial material; on uplands

This association consists mainly of soils on ridges and hills dissected by numerous drainageways and streams. Some slopes are long and smooth, and others are abrupt. Some areas on hilltops are gently sloping. Most areas have gravel, a few stones, and boulders on the surface. Slopes generally range from 3 to 30 percent.

This association makes up about 60 percent of the county. It is about 35 percent Pawnee soils, 9 percent Morrill soils, 9 percent Shelby soils, and 47 percent minor soils (fig. 2).

The Pawnee soils are moderately well drained. They commonly are gently sloping and strongly sloping and are on ridgetops and side slopes above the Morrill and Shelby soils. In most areas, they are eroded and the original clay subsoil is at the surface. Typically, the surface layer is dark brown, firm clay about 7 inches thick, but in some areas it is clay loam. The subsoil is very firm, mottled clay about 31 inches thick. It is dark grayish brown in the upper part, yellowish brown in the next part, and grayish brown in the lower part. The underlying material to a depth of more than 60 inches is grayish brown, mottled, calcareous clay loam.

The Morrill soils are well drained and are commonly eroded. They are strongly sloping and are on side slopes below the Pawnee soils. Typically, the surface layer is dark brown, friable clay loam about 7 inches thick. The subsoil is about 41 inches thick. It is dark reddish brown, friable clay loam in the upper part; yellowish red, friable clay loam in the next part; and yellowish red, friable sandy clay loam in the lower part. The underlying material to a depth of more than 60 inches is brown and yellowish red sandy loam.

The Shelby soils are well drained. They are commonly less eroded than the Pawnee and Morrill soils because they generally are not cultivated. They are moderately steep and steep and are on hills downslope from the Pawnee soils. Typically, the surface layer is very dark grayish brown, friable clay loam about 8 inches thick. The subsurface layer is very dark gray, friable clay loam about 7 inches thick. The subsoil is clay loam about 36 inches thick. The upper part is very dark grayish brown, the next part is dark yellowish brown and yellowish brown, and the lower part is pale brown. The underlying material to a depth of more than 70 inches is light brownish gray, mottled, calcareous clay loam.

The minor soils in this association are the Burchard, Dickinson, Judson, Malcolm, Mayberry, Nodaway, Steinauer, and Wymore soils. Burchard soils are in areas above the Shelby soils and below the Mayberry soils. They are shallower to carbonates than the Shelby soils. Dickinson, Malcolm, Mayberry, and Steinauer soils are lower on the landscape than the Pawnee soils. Dickinson soils contain more sand than the major soils, and Malcolm soils are siltier. Mayberry soils contain more clay in the subsoil than the Morrill and Shelby soils and are more reddish in the subsoil than the Pawnee soils. Steinauer soils have carbonates near the surface.

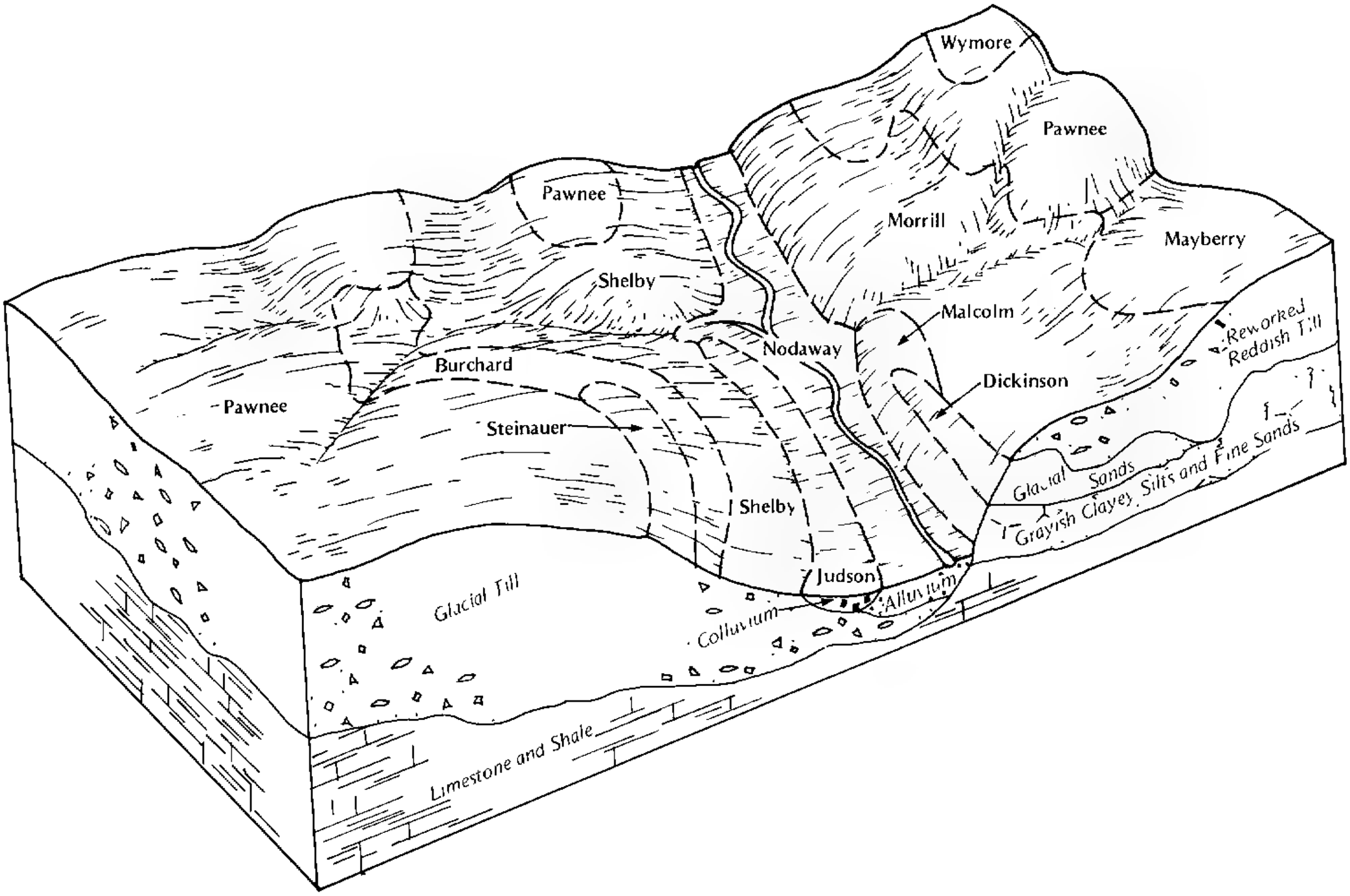


Figure 2.—Typical pattern of the soils and underlying material in the Pawnee-Morrill-Shelby association.

Judson soils are on foot slopes and formed in silty sediments. Nodaway soils are on bottom lands in narrow valleys along drainageways and formed in alluvium. Wymore soils are higher on the landscape than the major soils and formed in loess.

About 50 percent of this association is used for cultivated crops The rest is mainly pasture or range, although some small tracts are used for hay. Trees grow on some of the steeper slopes. The principal cultivated crops are grain sorghum, wheat, and alfalfa.

The soils in this association have medium potential for cultivated crops and high potential for grasses. They have high potential for wildlife habitat and recreation uses. Erosion is the principal hazard. Another management concern is maintaining fertility and the content of organic matter. In pastured areas controlled grazing and measures that ensure vigorous growth of the grasses are needed.

Farms in areas of this association are mainly the grain-forage-livestock type. In most areas the supply of good water from wells is limited, but it is generally adequate for domestic use. Rural water districts supply some farms with water through pipelines. A few springs are along the drainageways. In places surface water collected in farm ponds is a source of water for livestock. Many areas are potential sites for the construction of dams.

2. Wymore Association

Deep, nearly level and gently sloping, moderately well drained, clayey and silty soils that formed in loess; on uplands

This association consists mainly of soils on ridges, side slopes, and nearly level divides on some of the highest uplands in the county. The ridges and side slopes are uneven in width and length and in percent of slope. Several small waterways drain the association. Slopes range from 0 to 7 percent.

This association makes up about 25 percent of the county. It is about 85 percent Wymore soils and 15 percent minor soils (fig. 3).

The Wymore soils generally are eroded. Nearly all of the very dark, silty original surface soil has been removed. The original clayey subsoil is at or near the surface. Typically, the surface layer is very dark grayish brown, firm silty clay about 8 inches thick, but in some areas it is silty clay loam. The subsoil is very firm and firm, mottled silty clay about 24 inches thick. It is dark grayish brown in the upper part and grayish brown in the lower part. The underlying material to a depth of more than 70 inches is light brownish gray, mottled silty clay loam.

The minor soils in this association are the Judson, Nodaway, Pawnee, and Sharpsburg soils. Judson soils are on foot slopes and formed in silty sediments. Nodaway soils are on bottom lands and formed in alluvium. Pawnee soils formed in glacial material and are on hills downslope from the Wymore soils. Sharpsburg soils are in landscape positions similar to those of the Wymore soils. They have less clay in the subsoil than the Wymore soils.

In most areas, the soils in this association are used for cultivated crops. In some small tracts, they are planted to introduced grasses. The major crops are grain sorghum, wheat, corn, and soybeans. Alfalfa and clover are also grown.

The soils in this association have high potential for cultivated crops and pasture grasses. Erosion is the principal hazard. Other management concerns are maintaining the content of organic matter and soil structure and selecting crops that are best suited to the soils and climate. Complete conservation management should include terraces, contour farming, grassed waterways, and conservation tillage.

Growing cash crops and feed crops and raising livestock are the main agricultural enterprises. In most places, the supply of ground water is limited, but it is generally adequate for domestic use. In some local areas, deep wells are used for irrigation. Rural water districts supply some farms with water through pipelines.

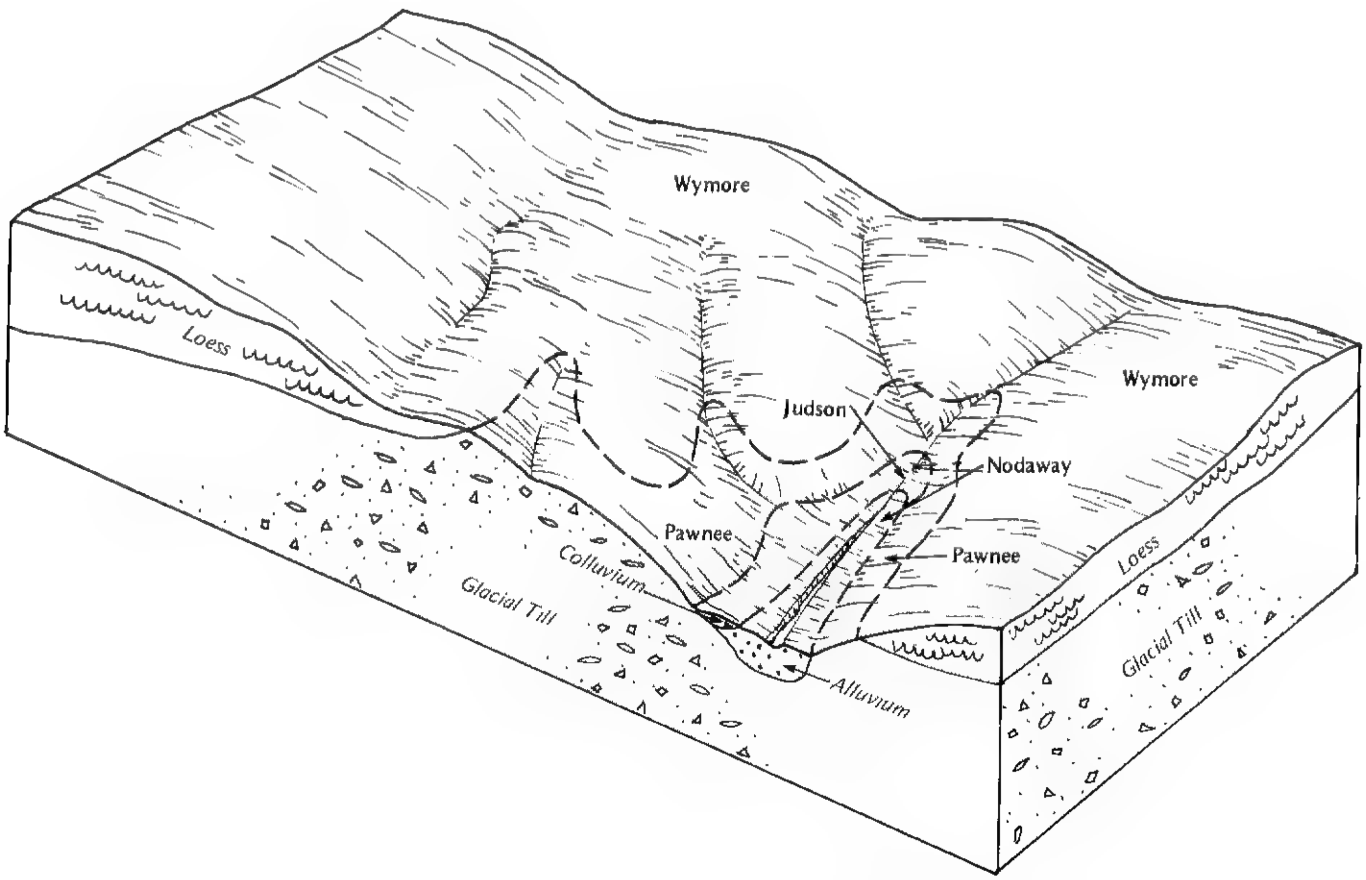


Figure 3.—Typical pattern of the soils and underlying material in the Wymore association.

Some farm ponds have multiple uses, including erosion control, watering of livestock, and recreation.

3. Nodaway-Zook-Judson Association

Deep, nearly level and gently sloping, moderately well drained, poorly drained, and well drained, silty soils that formed in alluvium and colluvium; on bottom lands, foot slopes, and stream terraces

This association consists mainly of soils on bottom lands at some of the lowest elevations in the county. The bottom lands are nearly 2 miles wide on the lower reaches of rivers but are less than 0.5 mile wide on the upper reaches of tributary creeks. Drainageways dissect the bottom lands. Some creek and river channels have been straightened. Most of the channels are deeply entrenched and have vertical banks. Gently sloping channel slopes and foot slopes are in some areas. Slopes range from 0 to 6 percent.

This association makes up about 15 percent of the county. It is about 41 percent Nodaway soils, 23 percent Zook soils, 16 percent Judson soils, and 20 percent minor soils (fig. 4).

The Nodaway soils are moderately well drained and are commonly adjacent to stream channels. They are nearly level and gently sloping. Typically, the surface layer is very dark grayish brown, friable silt loam about 5 inches thick. The underlying material to a depth of 60 inches or more is very dark grayish brown, dark grayish brown, and dark gray, stratified silt loam.

The Zook soils are poorly drained and are on nearly level slopes. They are commonly in areas some distance from the original main stream channels. Typically, the surface layer is black, friable silty clay loam about 8 inches thick. The subsurface layer is very dark gray, friable silty clay loam about 14 inches thick. The subsoil to a depth of more than 60 inches is very dark gray, mottled, firm silty clay.

The Judson soils are well drained. They are on stream terraces and foot slopes at the base of uplands. They are gently sloping. Typically, the surface layer is very dark grayish brown, friable silt loam about 10 inches thick. The subsurface layer is friable silty clay loam about 14 inches thick. It is black in the upper part and very dark brown in the lower part. The subsoil is friable silty

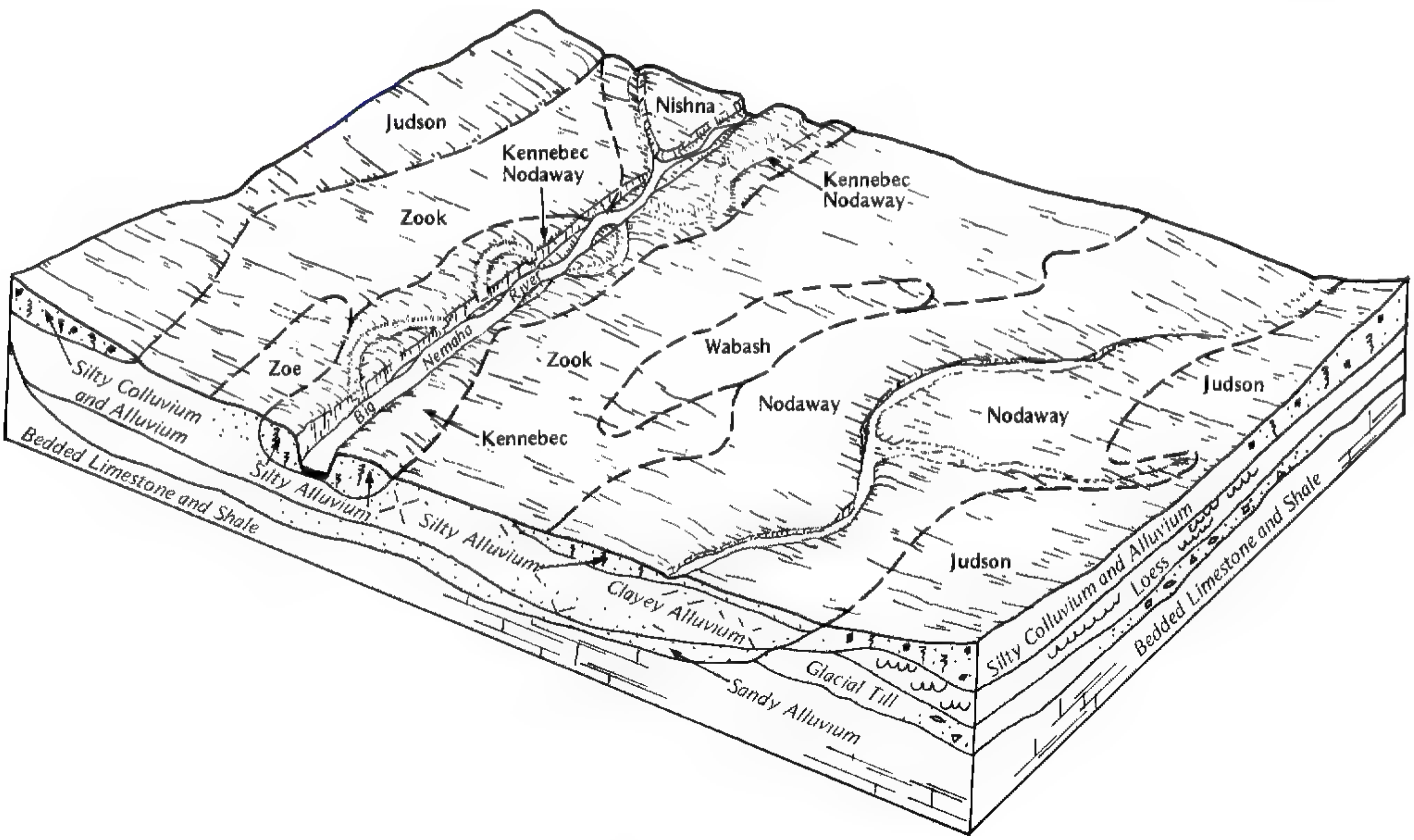


Figure 4.—Typical pattern of the soils and underlying material in the Nodaway-Zook-Judson association.

clay loam about 30 inches thick. It is dark brown in the upper part and brown in the lower part. The underlying material to a depth of 60 inches or more is brown silty clay loam.

The minor soils in this association are the Kennebec, Nishna, Wabash, and Zoe soils. Kennebec soils are moderately well drained and are in the higher areas on the bottom lands. Nishna soils are poorly drained and calcareous. Wabash soils are very poorly drained and clayey. Zoe soils are poorly drained and saline-alkali. Nishna, Wabash, and Zoe soils are on the lower parts of the landscape.

Nearly all the acreage of this association is cultivated. Numerous small, irregular tracts, however, are wooded. The soils have high potential for cultivated crops. The principal crops are corn, grain sorghum, and soybeans. Wetness and flooding in spring are the principal management concerns. Maintaining soil structure and the content of organic matter is also a concern.

Farms in areas of this association are either the cash-grain or grain-livestock type. Very few homes or other buildings are constructed in areas of these soils. Water for livestock is obtained from streams, a few springs, and shallow wells. In some local areas, deep wells are used for irrigation.

Detailed Soil Map Units

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under "Use and Management of the Soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil and gives the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer or of the underlying material, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the underlying material. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Wymore silty clay loam, 0 to 2 percent slopes, is one of several phases in the Wymore series.

Some map units are made up of two or more major soils. These map units are called soil complexes. A *soil complex* consists of two or more soils, or one or more soils and a miscellaneous area, in such an intricate pattern or in such small areas that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Kipson-Benfield complex, 11 to 25 percent slopes, is an example.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. The included soils are identified in each map unit description. Some small areas of strongly contrasting soils are identified by a special symbol on the soil maps.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of Tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils.

BrE2—Burchard-Steinauer clay loams, 9 to 15 percent slopes, eroded. These deep, well drained, moderately steep soils are on uplands. They formed in glacial till. In many areas, pebbles and cobblestones are on the surface. Slopes average about 11 percent. Areas are irregular in shape and range from about 10 to 100 acres in size. They are about 40 to 70 percent Burchard soil and 30 to 60 percent Steinauer soil. Generally, the Burchard soil is on concave, plane, and slightly convex slopes, and the Steinauer soil is on distinctive, rounded, convex slopes. The two soils occur as areas so intricately mixed that mapping them separately is not practical.

Most of the dark original surface layer of these eroded soils has been removed. In most areas, the original subsoil or underlying material is at the surface.

Typically, the Burchard soil has a surface layer of very dark grayish brown, friable clay loam about 5 inches thick. The subsoil is firm clay loam about 20 inches thick. It is calcareous at a depth of about 9 inches. The upper part is dark brown, the next part is brown, and the lower part is grayish brown and has dark yellowish brown mottles. The underlying material to a depth of 60 inches or more is light brownish gray, mottled, calcareous clay loam. In places, the soil is loam throughout. In small areas that are not eroded, the surface layer is more than 7 inches thick and lime is at a depth of more than 30 inches.

Typically, the Steinauer soil has a surface layer of dark grayish brown, friable, calcareous clay loam about 5

inches thick. The transitional layer is light brownish gray and dark yellowish brown, mottled, friable, calcareous clay loam about 7 inches thick. The underlying material to a depth of 60 inches is light brownish gray and yellowish brown, mottled, calcareous clay loam. In places, the soil is loam throughout. In a few places, slopes are less than 9 or more than 15 percent.

Included with these soils in mapping are small areas of Judson and Pawnee soils. Judson soils are dark to a depth of more than 24 inches. They are on foot slopes. Pawnee soils have a clay subsoil and are in the less sloping areas. In places, they are adjacent to drainageways. Also included are some deeply entrenched drainageways. Included areas make up 2 to 12 percent of the unit.

Permeability is moderately slow in the Burchard and Steinauer soils. Available water capacity is high; about 10 inches of water is available in the upper 60 inches. Organic matter content is moderate, or about 2 percent, in the Burchard soil and moderately low, or about 1 percent, in the Steinauer soil. Generally, the surface layer of the Burchard soil is neutral, and that of the Steinauer soil is moderately alkaline and has free lime. Both soils dry readily after rains and can be worked throughout a fairly wide range of moisture content.

About 75 percent of the acreage of these soils is cropland, and about 25 percent is used for pasture or range.

If used for dryland farming, these soils are poorly suited to cultivated crops. Water erosion is the principal hazard. Because of the moderately steep slopes, the effective use of some farm machinery is limited and terraces and grassed waterways cannot be easily designed and maintained. The best cropping system is one dominated by close-growing crops, such as small grain and legumes. Conservation tillage practices, such as chiseling and disking, that leave all or part of the crop residue on the surface help to control erosion, reduce the evaporation rate, and add organic matter. If clean-cultivated crops are grown, terraces, contour farming, and grassed waterways are needed to control water erosion. Intensive management is necessary in areas used for crop production; otherwise, the soils should be put to other uses.

If irrigated, these soils are poorly suited to corn, grain sorghum, and soybeans. They are best suited to alfalfa and introduced grasses. Only sprinkler irrigation systems are suited to the soils because of the moderately steep slopes. Water erosion is the main hazard. It can be a problem in the wheel tracks if center-pivot irrigation systems are used. Terraces, contour farming, and grassed waterways are needed to reduce the runoff rate and control erosion. A cover of crops or crop residue also helps to control erosion. Adjusting the rate at which water is applied to the water intake rate of the soils helps to prevent excessive runoff and erosion. Timely applications and efficient distribution of water are needed.

These soils are suited to introduced or domestic grasses for pasture. Pastures can be alternated with other crops as part of the crop rotation. Cool-season grasses, such as smooth brome and orchardgrass, are suited, either alone or in a mixture with a legume, such as alfalfa. Overgrazing causes low plant vigor and increases the likelihood that small gullies and rills will form during heavy rains. Separate pastures of cool- and warm-season grasses can be used to provide a long season of grazing. Rotation grazing and proper stocking rates help to keep the pasture in good condition. Nitrogen and phosphate fertilizers help to maintain the growth and vigor of the grasses.

These soils are suited to range and native hay. A permanent cover of grass is effective in controlling water erosion. The natural plant community is mostly mid and tall grasses, such as big bluestem, indiangrass, little bluestem, porcupinegrass, sideoats grama, and switchgrass. If the plants are overgrazed or improperly harvested for hay, the plant community is mostly sideoats grama, tall dropseed, Kentucky bluegrass, and annual and perennial weeds. If overgrazing continues for many years, eastern redcedar, snowberry, buckbrush, and sumac invade the plant community. The range condition can be improved or maintained by proper grazing use, timely deferment of grazing, and a grazing system that alternates grazing periods with rest periods and that includes a change in the order of these periods each year. Single species of grass, such as switchgrass and big bluestem, are tolerant of certain herbicides. A properly selected herbicide can be used to control undesirable weeds and grasses. Brush management and prescribed burning help to control woody plants. Range seeding improves the stand.

These soils are suited to the trees and shrubs grown as farmstead windbreaks and as plantings that enhance recreation areas and wildlife habitat. Survival and growth rates of adapted species are good on the Burchard soil and fair on the Steinauer soil. The best suited species are those that can tolerate the high lime content of the Steinauer soil. Water erosion is the principal problem. A combination of contour planting and terraces helps to prevent excessive runoff and water erosion. Cultivating the soil before and after planting helps to control plant competition. Rototillers can be used in the rows.

The moderately slow permeability is a limitation if these soils are used as septic tank absorption fields. Increasing the size of the absorption field helps to overcome this limitation. Generally, the absorption field should be constructed on the contour. The slope is a limitation on sites for sewage lagoons. An alternative site or disposal method should be selected. Strengthening the foundations of buildings and backfilling with coarse material help to prevent the structural damage caused by

shrinking and swelling. The design of buildings should accommodate the slope, or the site should be graded.

The surface pavement and base material of local roads and streets should be thick enough to compensate for the low strength of these soils.

The capability units are IVe-9, dryland, and IVe-3, irrigated. The Burchard soil is in Silty range site and windbreak suitability group 3. The Steinauer soil is in Limy Upland range site and windbreak suitability group 8.

DcD—Dickinson fine sandy loam, 6 to 11 percent slopes. This deep, strongly sloping, well drained soil is on knolls and short, uneven side slopes in the uplands. It formed in loamy and sandy material. Slopes are mostly convex and average about 9 percent. Areas range from 3 to 20 acres in size.

Typically, the surface layer is very dark brown, very friable fine sandy loam about 18 inches thick. The subsoil is about 19 inches thick. It is very dark grayish brown, very friable fine sandy loam in the upper part; dark brown, very friable fine sandy loam in the next part; and brown, very friable loamy fine sand in the lower part. The underlying material to a depth of 60 inches or more is pale brown fine sand. In a few areas, the subsoil is loam. In some small cultivated and eroded areas, the surface layer is thinner and is dark grayish brown loamy fine sand.

Included with this soil in mapping are some small areas of gravelly soils and small areas where cobbles and stones are on the surface. Also included are small areas of the silty Malcolm soils and the loamy Morrill and Shelby soils. Malcolm, Morrill, and Shelby soils are in positions on the landscape similar to those of the Dickinson soil. Included areas make up 2 to 12 percent of the unit.

Permeability is moderately rapid in the upper part of the Dickinson soil and rapid in the underlying material. Available water capacity is moderate; about 7 inches of water is available in the upper 60 inches. Organic matter content is moderately low, or about 1 or 2 percent. Reaction is medium acid or slightly acid throughout the profile. This soil dries quickly after rains and can be worked throughout a wide range of moisture content.

Most of the acreage of this soil supports grass and is used for pasture or range. A few areas are cultivated.

If used for dryland farming, this soil is poorly suited to row crops. It is better suited to small grain. Water erosion and drought are hazards. Applying a system of conservation tillage, such as chiseling and disking, that leaves all or part of crop residue on the surface reduces the evaporation rate and helps to control water erosion. Terracing and farming on the contour also help to control water erosion. Applications of fertilizer are needed.

If irrigated, this soil is poorly suited to corn, grain sorghum, and soybeans. It is better suited to alfalfa and introduced grasses. Only sprinkler irrigation systems are suited to this soil because of the slope. Water erosion is the main hazard. It can be a problem in the wheel tracks if center-pivot irrigation systems are used. Terraces, contour farming, and grassed waterways are needed to reduce the runoff rate and control erosion. A cover of crops or crop residue also helps to control erosion. Timely application and efficient distribution of water are needed.

This soil is suited to introduced or domestic grasses for pasture. Pastures can be alternated with other crops as part of the crop rotation. Cool-season grasses, such as smooth brome or orchardgrass, are suited, either alone or in a mixture with a legume, such as alfalfa. Overgrazing causes low plant vigor and increases the likelihood that small gullies and rills will form during heavy rains. Rotation grazing and proper stocking rates help to keep the pasture in good condition. Nitrogen and phosphate fertilizers help to maintain the growth and vigor of the grasses.

This soil is suited to range and native hay. A permanent cover of grass is effective in controlling water erosion. The natural plant community is mostly mid and tall grasses, such as indiangrass, little bluestem, big bluestem, switchgrass, sand lovegrass, and porcupinegrass. If the plants are overgrazed or improperly harvested for hay, the plant community is mostly porcupinegrass, prairie junegrass, Scribner panicum, sand dropseed, and annual and perennial weeds. The range condition can be improved or maintained by proper grazing use, timely deferment of grazing, and a grazing system that alternates grazing periods with rest periods and that includes a change in the order of these periods each year. Single species of grass, such as switchgrass and big bluestem, are tolerant of certain herbicides. A properly selected herbicide can be used to control undesirable weeds and grasses. Range seeding improves the stand.

This soil is suited to the trees and shrubs grown as windbreaks and as plantings that enhance recreation areas or wildlife habitat. Survival and growth rates of adapted species are fair. Erosion and a limited amount of available moisture are the main problems in establishing seedlings. Weeds can be controlled by cultivating with conventional equipment between the tree rows and by rototilling in the rows. A combination of contour planting and terraces helps to prevent excessive runoff and water erosion.

This soil readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in ground water pollution. Seepage is a hazard on sites for sewage lagoons. It can be controlled by lining or sealing the lagoon. Extensive grading is required to modify the slope and shape the lagoon. Dwellings and small commercial buildings should be designed to accommodate the slope, or the site should be graded.

The slope and frost action are limitations on sites for local roads and streets. Cutting and filling generally are needed for a suitable grade. Erosion on side banks and ditches can be controlled by mulching and by seeding a permanent cover of vegetation. A surface drainage system helps to prevent the damage to roads and streets caused by frost action. Crowning the road and establishing adequate side ditches help to drain the surface.

The capability units are IVe-3, dryland, and IVe-8, irrigated; Sandy range site; windbreak suitability group 5.

DcF—Dickinson fine sandy loam, 11 to 20 percent slopes. This deep, moderately steep, somewhat excessively drained soil is on uplands. It formed in sandy material. Areas range from about 5 to 60 acres in size.

Typically, the surface layer is very dark grayish brown, very friable fine sandy loam about 14 inches thick. The subsoil is about 22 inches thick. It is dark yellowish brown, very friable fine sandy loam in the upper part and yellowish brown, very friable loamy fine sand in the lower part. The underlying material to a depth of 60 inches or more is yellowish brown loamy fine sand. In places, the surface layer and subsoil are loamy fine sand. In a few small areas, the subsoil is very fine sandy loam or loam.

Included with this soil in mapping are small areas of gravelly soils and small areas where cobbles and stones are on the surface. Also included are small areas of the silty Malcolm soils and the loamy Shelby soils. The gravelly soils and the Malcolm and Shelby soils are in positions on the landscape similar to those of the Dickinson soil. Included areas make up 5 to 15 percent of the unit.

Permeability is moderately rapid in the upper part of the Dickinson soil and rapid in the underlying material. Available water capacity is moderate; about 7 inches of water is available in the upper 60 inches. Organic matter content is moderately low, or about 1 or 2 percent. This soil dries rapidly and can be worked throughout a wide range of moisture content.

Nearly all the acreage is used for pasture or range. This soil is not suited to cultivation. The moderately steep slope restricts the use of farm machinery. Erosion is a severe hazard if the soil is cultivated. Also, the soil is subject to drought because of the moderate available water capacity.

This soil is suited to range and native hay. A cover of native grasses is effective in controlling water erosion. The natural plant community is mostly mid and tall grasses, such as indiangrass, big bluestem, little bluestem, switchgrass, sand lovegrass, and porcupinegrass. If the plants are overgrazed or improperly harvested for hay, the plant community is mostly porcupinegrass, prairie junegrass, Scribner panicum, sand dropseed, and annual and perennial weeds. The range condition can be maintained or improved by proper grazing use, timely deferment of grazing, and a grazing system that alternates grazing periods with rest periods and that includes a change in the order of these periods each year. Range seeding can improve the stand.

This soil is suited to the trees and shrubs grown as windbreaks and as plantings that enhance recreation areas or wildlife habitat. Survival and growth rates of adapted species are fair. Water erosion and a limited amount of available moisture are problems in establishing seedlings. Conifers can be planted in a shallow furrow in native sod grass. Hardwoods can be planted in established tall stubble if the area has been row cropped the previous year. Carefully applying appropriate herbicides, hoeing by hand, or rototilling helps to control weeds.

Because of the moderately steep slope, a poor filtering capability, and seepage, this soil generally is not suited to sanitary facilities. The design of dwellings and other buildings should accommodate the slope, or the site should be graded.

The moderately steep slope is a limitation on sites for local roads and streets. Building on the contour or cutting and filling can result in a suitable grade. Erosion on side banks and ditches can be controlled by mulching and by seeding a permanent cover of vegetation.

The capability unit is VIe-3, dryland; Sandy range site; windbreak suitability group 5.

JuC—Judson silt loam, 2 to 6 percent slopes. This deep, gently sloping, well drained soil is on narrow foot slopes and stream terraces at the base of uplands. It formed in silty sediments. Areas range from 5 to 60 acres in size.

Typically, the surface layer is very dark grayish brown, friable silt loam about 10 inches thick. The subsurface layer is friable silty clay loam about 14 inches thick. It is black in the upper part and very dark brown in the lower part. The subsoil is friable silty clay loam about 30 inches thick. It is dark brown in the upper part and brown in the lower part. The underlying material to a depth of 60 inches or more is brown silty clay loam. In some areas on foot slopes below glacial soils, the surface layer is sandy loam, loam, or clay loam. In places, the subsoil is very dark grayish brown. In some areas, it is silty clay in the lower part. In places, the underlying material is clay loam.

Included with this soil in mapping are some areas of Pawnee and Wymore soils on the higher parts of the landscape. Also included are a few areas of the moderately well drained Nodaway and poorly drained Zook soils on the lower parts of the landscape. Pawnee and Wymore soils have a thin, dark surface layer and a clayey subsoil and are on uplands. Nodaway and Zook soils are on bottom lands below the Judson soil. Included soils make up 0 to 10 percent of the unit.

Permeability is moderate in the Judson soil. Available water capacity is high; about 12 inches of water is

available in the upper 60 inches. Organic matter content is high, or about 4 percent. This soil is slightly acid or neutral throughout. It dries readily after rains and can be worked throughout a fairly wide range of moisture content.

Most of the acreage of this soil is cultivated. Small tracts support grass and are used as pasture or range.

If used for dryland farming, this soil is suited to corn, grain sorghum, soybeans, wheat, alfalfa, clover, and grasses. Row crops, such as corn and soybeans, can be grown several years in succession, but weeds, plant diseases, and insects should be controlled. Water erosion is a moderate hazard. It can be controlled by conservation tillage and contour cultivation. Terraces and diversions can be used to intercept runoff from the upland slopes. The proper plant population and timely tillage are needed.

If irrigated, this soil is suited to corn, grain sorghum, and soybeans. Water erosion is the principal hazard. It can be controlled by conservation tillage practices, such as chiseling or disking, that leave all or part of the crop residue on the surface. Adjusting the rate at which water is applied to the water intake rate of the soil helps to prevent excessive runoff and erosion. If slopes are uniform, level benches or parallel terraces constructed at a proper grade also help to control erosion.

Gravity or sprinkler irrigation systems can be used on this soil. Less land preparation is needed if sprinkler systems are used. Timely application and efficient distribution of water are needed. Land leveling establishes a proper grade in areas irrigated by a gravity system. Reducing the grade in the rows by adjusting the direction of the rows helps to distribute the water evenly. It also helps to control erosion and increases the rate of water intake. Constructing a tailwater recovery system helps to conserve water.

This soil is suited to introduced or domestic grasses for pasture. Pastures can be alternated with other crops as part of the crop rotation. Cool-season grasses, such as smooth brome and orchardgrass, are suited, either alone or in a mixture with a legume, such as alfalfa. Overgrazing causes low plant vigor and increases the likelihood that small gullies and rills will form during heavy rains. Separate pastures of cool- and warm-season grasses can be used to provide a long season of grazing. Rotation grazing and proper stocking rates help to keep the pasture in good condition. Nitrogen fertilizers help to maintain the growth and vigor of the grasses.

This soil is suited to range and native hay. A cover of native grasses is effective in controlling water erosion. The natural plant community is mostly mid and tall grasses, such as big bluestem, indiangrass, little bluestem, porcupinegrass, sideoats grama, and switchgrass. If the plants are overgrazed or improperly harvested for hay, the plant community is mostly Kentucky bluegrass, sideoats grama, tall dropseed, and annual and perennial weeds. If overgrazing continues for many years, sumac, snowberry, and buckbrush invade the plant community. The range condition can be improved or maintained by proper grazing use, timely deferment of grazing, and a grazing system that alternates grazing periods with rest periods and that includes a change in the order of these periods each year. Brush management and prescribed burning help to control woody plants. Range seeding can improve the stand.

This soil is suited to the trees and shrubs grown as windbreaks and as plantings that enhance recreation areas or wildlife habitat. Seedlings of adapted species survive and grow well if moisture is conserved and weedy vegetation is controlled or removed. Cultivation between the tree rows with conventional equipment conserves moisture and helps to control weeds and grasses. Rototillers and herbicides can be used to control weeds in the rows. Planting the trees on the contour helps to control erosion.

This soil generally is suited to septic tank absorption fields. In most places, the slope can be modified for sewage lagoons. Lining or sealing the lagoon helps to prevent seepage. Strengthening the foundations of buildings and backfilling with coarse material help to prevent the structural damage caused by shrinking and swelling. Proper grading, constructing diversion terraces, or otherwise controlling runoff helps to prevent the damage caused by surface water.

The surface pavement and base of local roads and streets should be thick enough to compensate for the low strength of this soil. Providing coarser grained base material helps to ensure better performance. A surface drainage system helps to prevent the road damage caused by frost action. Crowning the road and establishing adequate side ditches help to drain the surface.

The capability units are IIe-1, dryland, and IIIe-4, irrigated; Silty range site; windbreak suitability group 3.

Ke—Kennebec silt loam, 0 to 1 percent slopes. This deep, nearly level, moderately well drained soil is on bottom lands. It formed in silty alluvium. It is subject to rare flooding. Areas are about 10 to more than 100 acres in size.

Typically, the surface layer is very dark gray, friable silt loam about 8 inches thick. The subsurface layer is black, friable silt loam about 20 inches thick. The transitional layer is very dark gray, friable silt loam about 11 inches thick. The underlying material to a depth of 60 inches or more is very dark grayish brown silty clay loam. In some areas, the underlying material is silty clay below a depth of 40 inches.

Included with this soil in mapping are some areas of Nodaway and Zook soils. Nodaway soils have a thin, dark surface layer and are in landscape positions similar to those of the Kennebec soil. Zook soils are poorly drained and are lower on the landscape than the

Kennebec soil. Also, they have more clay. Included soils make up 2 to 10 percent of the unit.

Permeability is moderate in the Kennebec soil. Available water capacity is high; about 13 inches of water is available in the upper 60 inches. Organic matter content is high, or about 5 percent. This soil is slightly acid or neutral throughout. The seasonal high water table is at a depth of 4 to 6 feet. The soil dries readily after rains and can be worked throughout a wide range of moisture content.

Nearly all of the acreage is cultivated. If used for dryland farming, this soil is suited to corn, grain sorghum, soybeans, wheat, alfalfa, clover, and grasses. If properly managed, it can be intensively cultivated. Row crops, such as corn and soybeans, can be grown several years in succession, but weeds, insects, and plant diseases should be controlled. The plant population should be based on the amount of available soil moisture. Returning plant residue to the soil increases the rate of water intake and helps to maintain the organic matter content. Delaying tillage when the soil is too wet helps to prevent compaction and preserves soil structure.

If irrigated, this soil is suited to corn, grain sorghum, and soybeans. If well managed, it can be intensively cultivated. Conservation tillage practices, such as chiseling or disking, that leave all or part of the crop residue on the surface conserve moisture and help to maintain the organic matter content. Adjusting the rate at which water is applied to the intake rate of the soil helps to control runoff.

Gravity or sprinkler irrigation systems can be used on this soil. Less land preparation is needed if sprinkler systems are used. Timely application and efficient distribution of water are needed. Land leveling establishes a proper grade in areas irrigated by a gravity system. Constructing a tailwater recovery system helps to conserve water.

This soil is suited to the trees and shrubs grown as windbreaks and as plantings that enhance recreation areas or wildlife habitat. Seedlings of adapted species survive and grow well if moisture is conserved and weeds are controlled. Weeds and grasses can be controlled by cultivating with conventional equipment between the rows and by rototilling and applying appropriate herbicides in the rows.

Because of the hazard of flooding, this soil is limited as a site for sanitary facilities and buildings. Constructing buildings on elevated, well compacted fill material protects them from floodwater. Lining or sealing the bottom of sewage lagoons helps to prevent seepage. Dikes protect the lagoons from flooding.

Frost action and low strength are the main limitations on sites for local roads and streets. Installing a good surface drainage system helps to prevent the damage to roads caused by frost action. Crowning the road by grading and establishing adequate side ditches help to drain the surface. Constructing the roads on fill material protects them from flooding. The surface pavement and base material should be thick enough to compensate for the low strength of the soil. Providing coarser grained base material helps to ensure better performance.

The capability units are I-1, dryland, and I-6, irrigated; Silty Lowland range site; windbreak suitability group 1.

KnB—Kennebec-Nodaway silt loams, 0 to 4 percent slopes. These deep, nearly level and very gently sloping, moderately well drained soils formed in silty alluvium on bottom lands. They are adjacent to and in the original channels of the major streams. The Kennebec soil is rarely flooded, and the Nodaway soil is occasionally flooded. Areas are long and narrow and are 10 to more than 80 acres in size. They are about 50 to 60 percent nearly level Kennebec soil on the edges of channel slopes, 25 to 35 percent very gently sloping Nodaway soil on the channel slopes, and 10 to 15 percent nearly level Nodaway soil in the channel bottoms. The two soils occur as areas so intricately mixed that mapping them separately is not practical.

Typically, the Kennebec soil has a surface layer of very dark gray, friable silt loam about 8 inches thick. The subsurface layer is friable silt loam about 28 inches thick. It is black in the upper part and very dark gray in the lower part. The underlying material to a depth of more than 60 inches is very dark grayish brown silt loam.

Typically, the Nodaway soil has a surface layer of very dark grayish brown, friable silt loam about 7 inches thick. The underlying material to a depth of more than 60 inches occurs as finely stratified layers of dark grayish brown and grayish brown silt loam.

Included with these soils in mapping are intermittent streams and small narrow ponds in channel bottoms. Also included are areas of soils that have slopes of 8 percent or more. Included areas make up 0 to 10 percent of the unit.

Permeability is moderate in the Kennebec and Nodaway soils. Available water capacity is high; about 13 inches of water is available in the upper 60 inches. Organic matter content is high, or about 5 percent, in the Kennebec soil and moderate, or about 2 percent, in the Nodaway soil. Reaction is slightly acid or neutral throughout both soils. The seasonal high water table is at a depth of 4 to 6 feet in the Kennebec soil and 3 to 5 feet in the Nodaway soil. Both soils dry quickly after rains and can be worked throughout a wide range of moisture content.

Most of the acreage of these soils is cultivated. Small areas along stream channels are wooded and are used mainly as wildlife habitat.

If used for dryland farming, these soils are suited to corn, grain sorghum, soybeans, wheat, alfalfa, clover, and grasses. Row crops, such as corn, can be grown several years in succession, but weeds, plant diseases, and insects should be controlled. The occasional flooding in the low channel areas and runoff and erosion

on the adjacent channel slopes are hazards. Flood-control structures have been constructed in the upstream watershed. Timely tillage and conservation tillage are needed on the local flood plain. Timely tillage helps to prevent compaction and maintains soil structure. Returning plant residue to the soil increases the rate of water intake and helps to control runoff and local flooding. The plant residue also helps to maintain the organic matter content. Applying fertilizer and including legumes in the cropping system help to maintain fertility.

If irrigated, these soils are suited to corn, grain sorghum, and soybeans. The areas are too irregular and steep for gravity irrigation but are suited to sprinkler irrigation. The occasional flooding in low channel areas and runoff on the adjacent channel slopes are hazards. They can be controlled by conservation tillage practices, such as chiseling or disking, that leave all or part of the crop residue on the surface. Adjusting the rate at which water is applied to the water intake rate of the soils helps to prevent excessive runoff. Timely application and efficient distribution of water are needed.

These soils are suited to the trees and shrubs grown as windbreaks and as plantings that enhance recreation areas or wildlife habitat. Seedlings of adapted species survive and grow well if moisture is conserved and weeds are controlled. Weeds and grasses can be controlled by conventional equipment between the tree rows and by hand hoeing, rototilling, and applying appropriate herbicides in the rows.

In areas of the Kennebec soil at the higher elevations, constructing buildings on elevated, well compacted fill material helps to protect them from rare flooding. Because of occasional flooding, the Nodaway soil is not suitable as a site for buildings. Sealing the bottom of sewage lagoons helps to prevent seepage. Dikes help to protect the lagoons from flooding.

Frost action, low strength, and the flooding are the main limitations on sites for local roads and streets. A surface drainage system helps to prevent the damage caused by frost action. Crowning the road by grading and establishing adequate side ditches help to drain the surface. The surface pavement and base material should be thick enough to compensate for the low strength. Providing coarser grained base material helps to ensure better performance. Constructing the roads on suitable, well compacted fill material above flood levels, establishing side ditches, and installing culverts help to prevent the damage caused by flooding.

The capability units are IIw-3, dryland, and IIw-6, irrigated; windbreak suitability group 1. The Kennebec soil is in Silty Lowland range site, and the Nodaway soil is in Silty Overflow range site.

KpF—Kipson-Benfield complex, 11 to 25 percent slopes. This map unit consists of a shallow, somewhat excessively drained Kipson soil and a moderately deep, well drained Benfield soil. These soils are on knolls and short, uneven side slopes in the uplands. They are moderately steep and steep. The Kipson soil commonly is in the steeper areas. Limestone or shale fragments commonly are on the surface. Areas are oblong and range from 5 to more than 100 acres in size. They are about 60 percent Kipson soil and 40 percent Benfield soil. The two soils occur as areas so intricately mixed that mapping them separately was not practical.

Typically, the Kipson soil has a surface layer of very dark grayish brown, friable, calcareous flaggy silty clay loam about 7 inches thick. Limestone fragments 1 to 15 inches long commonly are at the surface. In areas where they are mixed with the soil, they make up about 20 percent of the surface layer. The transition layer is dark grayish brown, friable, calcareous channery silty clay loam about 6 inches thick. Stone fragments less than 3 inches in size make up about 25 percent of this layer. The underlying material is olive brown silty clay loam. Olive and weak red, bedded shale is at a depth of 18 inches. In some places, the surface layer is thicker and does not have stone fragments. In other places, the depth to bedded shale is more than 20 inches

Typically, the Benfield soil has a surface layer of very dark grayish brown, friable silty clay loam about 10 inches thick. The subsoil is about 26 inches thick. It is dark brown, friable silty clay loam in the upper part; brown and dark yellowish brown, firm silty clay in the next part; and light olive brown, firm, calcareous silty clay loam in the lower part. Light yellowish brown, calcareous bedded shale is at a depth of about 36 inches. In places, the soil is calcareous near the surface.

Included with these soils in mapping are small abandoned stone quarries and areas of rock outcrop on ledges. Included areas make up 0 to 12 percent of the unit.

Permeability is moderate in the Kipson soil and slow in the Benfield soil. Available water capacity is low in the Kipson soil and moderate in the Benfield soil. Organic matter content is moderate in both soils.

Most of the acreage of these soils is used for pasture or range. Small areas along the edge of the map unit are cultivated. A few areas support some small shrubs or trees. A few are used as habitat for wildlife.

These soils are not suited to cultivated crops. They are suited to range. A cover of range plants is effective in controlling water erosion. The natural plant community is mostly mid and tall grasses, such as big bluestem, little bluestem, indiangrass, sideoats grama, and switchgrass. If the plants are overgrazed, the plant community is mostly sideoats grama, blue grama, and many annual and perennial weeds. If overgrazing continues for many years, bur oak, sumac, dogwood, snowberry, and buckbrush invade the plant community. The range condition can be improved or maintained by proper grazing use, timely deferment of grazing, and a grazing system that alternates grazing periods with rest periods and that includes a change in the order of these

periods each year. Brush management and prescribed burning help to control the woody plants.

The Kipson soil generally is unsuited and the Benfield soil poorly suited to the trees and shrubs grown as windbreaks and as plantings that enhance recreation areas or wildlife habitat. The flagstones, the slope, and a limited supply of available moisture are problems. Survival and growth rates of adapted species are poor on the Kipson soil and fair on the Benfield soil. Hand planting or scalp planting and hand hoeing or rototilling are suitable on the Benfield soil.

These soils are poorly suited to buildings. The shallowness to bedrock, the shrink-swell potential, and the slope are limitations. Because of the depth to bedrock, the soils are better suited to buildings without basements than to buildings with basements. Strengthening foundations and backfilling with coarse material help to prevent the structural damage caused by shrinking and swelling. The design of the buildings should accommodate the slope, or the site should be graded.

These soils generally are not suitable as sites for septic tank absorption fields because of the shallowness of the Kipson soil, the slow permeability in the Benfield soil, and the slope of both soils. They generally are not suitable as sites for sewage lagoons because of the shallowness to bedrock and the slope.

Low strength and the slope are limitations on sites for local roads and streets. The surface pavement and base material should be thick enough to compensate for the low strength of these soils. Providing coarser grained base material helps to ensure better performance. Cutting and filling are generally needed for a suitable grade.

The capability unit is VIs-4, dryland; windbreak suitability group 10. The Kipson soil is in Shallow Limy range site, and the Benfield soil is in Clayey range site.

MaD—Malcolm silt loam, 5 to 11 percent slopes. This deep, strongly sloping, well drained soil is on convex side slopes in the uplands. It formed in silty deposits. Areas range from about 5 to 20 acres in size.

Typically, the surface layer is very dark grayish brown, friable silt loam about 6 inches thick. The subsoil is friable silty clay loam about 24 inches thick. The upper part is very dark grayish brown, the next part is brown, and the lower part is grayish brown and is mottled with yellowish brown. The underlying material to a depth of more than 60 inches is light brownish gray, mottled silt loam. In small eroded areas, the soil is dark to a depth of only 5 to 8 inches. In a few places, the underlying material has layers of silty clay loam or fine sandy loam

Included with this soil in mapping are small areas of Dickinson, Mayberry, Morrill, and Shelby soils. These soils are in positions on the landscape similar to those of the Malcolm soil. Dickinson soils formed in loamy and sandy materials. Mayberry soils are moderately well drained. Morrill and Shelby soils formed in loamy material. Also included are small areas of gravelly or stony soils. Included soils make up about 2 to 10 percent of the unit.

Permeability is moderate in the Malcolm soil. Available water capacity is high; about 12 inches of water is available in the upper 60 inches. Organic matter content is moderate, or about 2 percent. This soil is slightly acid or medium acid throughout. It dries readily after rains and can be easily worked throughout a fairly wide range of moisture content.

About 60 percent of the acreage of this soil is cultivated. The rest is used as pasture or range.

If used for dryland farming, this soil is poorly suited to grain sorghum, corn, wheat, soybeans, oats, alfalfa, and forage sorghum. Water erosion and the loss of moisture through runoff are the principal hazards. Applying a system of conservation tillage and returning crop residue to the soil increase the rate of water intake and help to maintain the content of organic matter. Terraces, grassed waterways, and contour farming help to control runoff and water erosion. Row crops can be grown more frequently if these measures are applied. The soil can be protected by the limited use of clean-cultivated row crops and the maximum use of close-growing small grain, legumes, or legume-grass mixtures.

If irrigated, this soil is poorly suited to corn, grain sorghum, and soybeans. It is best suited to alfalfa and introduced grasses. Only sprinkler irrigation systems are suited to this soil because of the slope. Water erosion is the main hazard. It can be a problem in the wheel tracks if center-pivot irrigation systems are used. Terraces, contour farming, and grassed waterways are needed to control runoff and erosion. A cover of crops or crop residue also helps to control erosion. Carefully adjusting the rate at which water is applied to the water intake rate of the soil helps to prevent excessive runoff and erosion. Timely application and efficient distribution of water are needed.

This soil is suited to introduced or domestic grasses for pasture. Pastures can be alternated with other crops as part of the crop rotation. Cool-season grasses, such as smooth brome or orchardgrass, are suited, either alone or in a mixture with a legume, such as alfalfa. Overgrazing causes low plant vigor and increases the likelihood that small gullies and rills will form during heavy rains. Separate pastures of cool- and warm-season grasses can be used to provide a long season of grazing. Rotation grazing and proper stocking rates help to keep the pasture in good condition. Nitrogen and phosphate fertilizers help to maintain the growth and vigor of the grasses.

This soil is suited to range and native hay. A cover of native grasses is effective in controlling water erosion. The natural plant community is mostly mid and tall grasses, such as big bluestem, indiangrass, little bluestem, porcupinegrass, sideoats grama, and

switchgrass. If the plants are overgrazed or improperly harvested for hay, the plant community is mostly Kentucky bluegrass, sideoats grama, tall dropseed, and annual and perennial weeds. If overgrazing continues for many years, sumac, snowberry, and buckbrush invade the plant community. The range condition can be improved or maintained by proper grazing use, timely deferment of grazing, and a grazing system that alternates grazing periods with rest periods and that includes a change in the order of these periods each year. Brush management and prescribed burning help to control woody plants. Range seeding can improve the stand.

This soil is suited to the trees and shrubs grown as windbreaks and as plantings that enhance recreation areas or wildlife habitat. Adapted species survive and grow well. Plant competition and erosion are the principal hazards. Cultivating before planting helps to store moisture in the soil. Cultivating after planting helps to control weeds. Rototillers or appropriate herbicides can be used in the tree rows. Planting the seedlings on the contour helps to control erosion. The plants should be protected from the damage caused by livestock.

This soil generally is suitable as a site for septic tank absorption fields. The design of the field should accommodate the slope. The soil is not suitable as a site for sewage lagoons because of the slope. An alternative site should be considered. The design of dwellings and small commercial buildings should accommodate the slope, or the site should be graded. Strengthening foundations and backfilling with coarse material help to prevent the structural damage caused by shrinking and swelling.

Frost action and low strength are limitations on sites for local roads and streets. A surface drainage system helps to prevent the damage caused by frost action. Crowning the road and establishing adequate side ditches help to drain the surface. The surface pavement and base material should be thick enough to compensate for the low strength of this soil. Providing coarser grained base material helps to ensure better performance.

The capability units are IVe-1, dryland, and IVe-6, irrigated; Silty range site; windbreak suitability group 3.

MaF—Malcolm silt loam, 11 to 25 percent slopes. This deep, moderately steep and steep, somewhat excessively drained soil is on uneven side slopes in the uplands. It formed in silty deposits. Areas range from about 5 to 25 acres in size.

Typically, the surface layer is very dark brown, friable silt loam about 12 inches thick. The subsoil is friable silty clay loam about 18 inches thick. The upper part is very dark grayish brown, the next part is dark brown, and the lower part is light olive brown and is mottled with dark yellowish brown. The underlying material to a depth of more than 65 inches is silt loam. It is light yellowish brown in the upper part and light brownish gray and mottled in the lower part. In some places, the surface layer is loam. In other places, the subsoil is very fine sandy loam. In small eroded areas, the surface layer is very thin and the subsoil is thin.

Included with this soil in mapping are small areas of gravelly, stony, or bouldery soils. Also included are small areas of Dickinson, Morrill, and Shelby soils. Dickinson soils formed in loamy and sandy materials, and Morrill and Shelby soils formed in loamy material. All of the included soils are in positions on the landscape similar to those of the Malcolm soil. They make up 2 to 15 percent of the unit.

Permeability is moderate in the Malcolm soil. Available water capacity is high. Organic matter content is moderate. This soil is slightly acid or medium acid throughout.

Most of the acreage is used for pasture or range. This soil is not suited to cultivated crops because of the slope and a severe hazard of erosion.

This soil is suited to range and native hay. A cover of native grasses is effective in controlling water erosion. The natural plant community is mostly mid and tall grasses, such as big bluestem, indiangrass, little bluestem, porcupinegrass, sideoats grama, and switchgrass. If the plants are overgrazed or improperly harvested for hay, the plant community is mostly Kentucky bluegrass, sideoats grama, tall dropseed, and many annual and perennial weeds. If overgrazing continues for many years, sumac, snowberry, and buckbrush invade the plant community. The range condition can be improved or maintained by proper grazing use, timely deferment of grazing, and a grazing system that alternates grazing periods with rest periods and that includes a change in the order of these periods each year. Brush management and prescribed burning help to control woody plants. Range seeding can improve the stand.

This soil is suited to the trees and shrubs grown as windbreaks and as plantings that enhance recreation areas or wildlife habitat. Survival and growth rates of adapted species are good. Plant competition is the main limitation in establishing seedlings. Runoff and erosion are hazards. Planting the seedlings on the contour and establishing intervening strips of sod help to control erosion. Hand hoeing, rototilling, or applying appropriate herbicides helps to control weeds in the tree rows after planting. The windbreak should be protected from the damage caused by livestock.

Because of the slope, this soil generally is not suitable as a site for sanitary facilities. A suitable alternative site should be considered. The design of dwellings and other buildings should accommodate the slope, or the site should be graded.

The slope, frost action, and low strength are limitations on sites for local roads and streets. A suitable grade generally can be established by cutting and filling or by

building on the contour. The road damage caused by frost action can be minimized by crowning the road and establishing adequate side ditches, which improve surface drainage. Mulching and seeding side banks and ditches help to control erosion. The surface pavement and base material should be thick enough to compensate for the low strength of the soil. Providing coarser grained base material helps to ensure better performance.

The capability unit is VIe-1, dryland; Silty range site; windbreak suitability group 3.

MeC—Mayberry clay loam, 3 to 9 percent slopes. This deep, gently sloping and strongly sloping, moderately well drained soil is on uplands. It is on knolls and side slopes and in some areas next to drainageways. It formed in clayey and loamy, reworked glacial material. Slopes average about 6 percent. Areas range from about 5 to 80 acres in size.

Typically, the surface layer is very dark brown, friable clay loam about 12 inches thick. The subsurface layer is dark brown, firm clay loam about 4 inches thick. The subsoil is clay about 40 inches thick. The upper part is reddish brown and very firm. The next part is brown and strong brown and is very firm. The lower part is brown, mottled, and very firm and firm. The underlying material to a depth of more than 75 inches is pale brown and reddish brown clay loam. In some areas, the surface layer is silty clay loam. In other areas, the subsoil is dark grayish brown silty clay. In some places, the upper part of the subsoil, at a depth of 10 to 24 inches, is clay loam. In other places, the underlying material is sand, silt loam, silty clay, or clay below a depth of 40 inches. In some areas on the lower slopes, the soil is dark to a depth of more than 20 inches.

Included with this soil in mapping are small areas of Judson, Malcolm, Morrill, and Shelby soils. Judson soils are dark to a depth of more than 24 inches. They are on foot slopes. Malcolm, Morrill, and Shelby soils have less clay in the subsoil than the Mayberry soil. They are in positions on the landscape similar to those of the Mayberry soil. Also included are some small areas of gumbo, scabby spots, and a few small areas of gravelly and stony soils. Included areas make up 2 to 15 percent of the unit.

Permeability is slow in the Mayberry soil. Available water capacity is moderate; about 8 inches of water is available in the upper 60 inches. Organic matter content is moderate, or about 3 percent. The surface layer and the upper part of the subsoil are slightly acid or medium acid. A perched seasonal high water table is at a depth of 1 to 3 feet in the spring. The soil dries slowly and stays wet during prolonged periods of rainfall. Workability is fairly good only during periods of optimum moisture content. The soil releases moisture slowly to plants.

About 40 percent of the acreage of this soil is cultivated. The rest is used for pasture or range.

If used for dryland farming, this soil is suited to grain sorghum, wheat, corn, soybeans, oats, forage sorghum, and alfalfa. Because of the moderate available moisture capacity, it is best suited to cool-season small grain, such as wheat, or drought-resistant crops, such as sorghum. Water erosion is a major hazard. Loss of soil nutrients and of soil moisture through runoff is a management concern. Applying a system of conservation tillage and returning crop residue to the soil increase the rate of water intake, reduce the evaporation rate, help to maintain the content of organic matter, and reduce the susceptibility to water erosion. The excessive compaction caused by tillage should be avoided, particularly when the soil is wet, because it further restricts permeability. Timely tillage minimizes compaction and helps to preserve soil structure. Terraces, grassed waterways, and contour farming help to control runoff and erosion. Row crops can be grown more frequently if these measures are applied.

This soil can be protected from severe erosion by limiting the use of clean-cultivated row crops and by making maximum use of close-growing small grain, legumes, or legume-grass mixtures. Legumes in the cropping sequence add nitrogen to the soil and help to maintain soil structure and soil porosity.

If irrigated, this soil is poorly suited to corn, grain sorghum, and soybeans. It is best suited to alfalfa and introduced grasses. Only sprinkler irrigation systems are suited to this soil because of the slope. Water erosion is the main hazard. It can be a problem in the wheel tracks if center-pivot irrigation systems are used. Terraces, contour farming, and grassed waterways are needed to control runoff and erosion. A cover of crops or crop residue also helps to control erosion. Adjusting the rate at which water is applied to the water intake rate of the soil helps to prevent excessive runoff and erosion. Timely application and efficient distribution of water are needed.

This soil is suited to introduced or domestic grasses for pasture. Pastures can be alternated with other crops as part of the crop rotation. Cool-season grasses, such as smooth brome and orchardgrass, are suited, either alone or in a mixture with a legume, such as alfalfa. Overgrazing causes low plant vigor and increases the likelihood that small gullies and rills will form during heavy rains. Separate pastures of cool- and warm-season grasses can be used to provide a long season of grazing. Rotation grazing and proper stocking rates help to keep the pasture in good condition. Nitrogen and phosphate fertilizers help to maintain the growth and vigor of the grasses.

This soil is suited to range and native hay. A cover of native grasses is effective in controlling water erosion. The natural plant community is mostly mid and tall grasses, such as big bluestem, indiangrass, little bluestem, porcupinegrass, and switchgrass. If the plants are overgrazed or improperly harvested for hay, the plant

community is mostly sideoats grama, tall dropseed, Kentucky bluegrass, and annual and perennial weeds If overgrazing continues for many years, sumac, snowberry, and buckbrush invade the plant community. The range condition can be improved or maintained by proper grazing use, timely deferment of grazing, and a grazing system that alternates grazing periods with rest periods and that includes a change in the order of these periods each year. Brush management and prescribed burning help to control woody plants. Range seeding can improve the stand.

This soil is poorly suited to the trees and shrubs grown as windbreaks and as plantings that enhance recreation areas or wildlife habitat. Adapted species have a fair chance of survival and growth. The soil absorbs and releases moisture too slowly, however, to sustain good tree growth. Plant competition and erosion are the principal hazards. Cultivating before planting helps to store moisture in the soil. Cultivating after planting helps to control weeds and minimizes cracking and drying. Conventional equipment can be used to cultivate between the tree rows, and rototillers or appropriate herbicides can be used in the rows. Planting on the contour helps to control erosion.

Because of the slow permeability, this soil is not suited to septic tank absorption fields. A suitable alternative system is needed. The soil is suitable as a site for sewage lagoons, but grading is required to modify the slope and shape the lagoon. The wetness and a high shrink-swell potential in the subsoil are the main limitations on sites for dwellings and small commercial buildings. Strengthening foundations and backfilling with coarse material help to prevent the structural damage caused by shrinking and swelling. On sites for dwellings with basements, a tile drainage system at the floor level carries away seepage water when the soil is saturated. A suitable outlet is needed. Grading helps to keep surface runoff away from the buildings.

Low strength, frost action, and the high shrink-swell potential are limitations on sites for local roads and streets. The surface pavement and base material should be thick enough to compensate for the low strength of the soil. Providing coarser grained base material helps to ensure better performance. Grading and crowning the road and establishing adequate side ditches improve surface drainage and thus help to prevent the damage caused by frost action. Mixing the base material with additives, such as hydrated lime, helps to prevent excessive shrinking and swelling.

The capability units are IIIe-2, dryland, and IVe-1, irrigated; Clayey range site; windbreak suitability group 4C.

MfC2—Mayberry clay, 3 to 9 percent slopes, eroded. This deep, gently sloping and strongly sloping, moderately well drained soil is on knolls and side slopes in the uplands. It formed in clayey and loamy, reworked glacial material. Except those in areas adjacent to drainageways, slopes are convex. They average about 6 percent. Gravel is on the surface. Areas range from about 5 to 80 acres in size.

Most of the very dark original surface soil of this eroded soil has been removed. The surface layer is mostly subsoil material. Typically, it is dark brown, firm clay about 5 inches thick. The subsoil is about 49 inches thick. It is yellowish red, mottled, very firm clay in the upper part, and yellowish red and brown, mottled, firm clay loam in the lower part. The underlying material to a depth of more than 70 inches is pale brown, mottled, stratified, calcareous silt loam and very fine sandy loam. In several areas, the subsoil is dark grayish brown or grayish brown. In some areas, the underlying material is grayish, is stratified, has differing amounts of clay, and typically is very fine sandy loam, silt loam, silty clay loam, or silty clay. In other areas, it is sand or clay below a depth of 40 inches.

Included with this soil in mapping are small areas of Judson, Malcolm, Morrill, Shelby, and Wymore soils. Judson soils are dark to a depth of more than 24 inches. They are on foot slopes. Malcolm, Morrill, and Shelby soils have less clay than the Mayberry soil. They are in positions on the landscape similar to those of the Mayberry soil. Wymore soils formed in loess and are upslope from the Mayberry soil. Also included are gumbo or scabby spots and a few small areas of gravelly and stony soils. Included areas make up 5 to 15 percent of the unit.

Permeability is slow in the Mayberry soil. Available water capacity is moderate; about 8 inches of water is available in the upper 60 inches. Organic matter content is moderate, or about 2 percent. Generally, this soil is slightly acid in the surface layer and neutral in the subsoil. Workability is fairly good only during periods of optimum moisture content. The soil is sticky when wet, tough when moist, and very hard when dry. It cracks as it dries. A perched seasonal high water table is at a depth of 1 to 3 feet in the spring. The soil dries slowly and stays wet during continued periods of rain. It releases moisture slowly to plants.

About 60 percent of the acreage of this soil is cultivated. The rest has been reseeded to grass and is used as pasture or range.

If used for dryland farming, this soil is poorly suited to cultivated crops. Because of the moderate available water capacity, it is best suited to cool-season small grain, such as oats and wheat, or to drought-resistant crops, such as grain sorghum and forage sorghum. Water erosion is a major hazard. Other management concerns are conserving moisture and improving the organic matter content, the fertility level, and the workability of the soil. If the soil is used for continuous row crops, erosion is difficult to control. Applying a system of conservation tillage and returning crop residue to the soil increase the rate of water intake, reduce the

evaporation rate, add organic matter, and help to control water erosion. The excessive compaction caused by tillage should be avoided, particularly when the soil is wet, because it further restricts permeability. Timely tillage minimizes soil compaction and helps to preserve soil structure. Terracing and contour farming help to control erosion. Grassed waterways can be used to carry water from fields at a nonerosive velocity. The soil can be protected by limited use of clean-cultivated row crops and maximum use of close-growing small grain, legumes, or legume-grass mixtures. Barnyard manure and commercial fertilizers improve fertility.

If irrigated, this soil is poorly suited to corn, grain sorghum, and soybeans. It is best suited to alfalfa and introduced grasses. Only sprinkler irrigation systems can be used because of the slope. Water erosion is the main hazard. It can be a problem in the wheel tracks if center-pivot irrigation systems are used. Terraces, contour farming, and grassed waterways are needed to control runoff and erosion. Adjusting the rate at which water is applied to water intake rate of the soil helps to prevent excessive runoff and erosion. Timely application and efficient distribution of water are needed.

This soil is suited to introduced or domestic grasses for pasture. Pastures can be alternated with other crops as part of the crop rotation. Cool-season grasses, such as smooth brome or orchardgrass, are suited, either alone or in a mixture with a legume, such as alfalfa. Overgrazing or grazing during wet periods compacts the soil. Overgrazing also causes low plant vigor and increases the likelihood that small gullies and rills will form during heavy rains. Separate pastures of cool- and warm-season grasses can be used to provide a long season of grazing. Rotation grazing and proper stocking rates help to keep the pasture in good condition. Nitrogen and phosphate fertilizers help to maintain the growth and vigor of the grasses.

This soil is suited to range and native hay. A cover of native grasses is effective in controlling water erosion. The natural plant community is mostly mid and tall grasses, such as big bluestem, indiangrass, little bluestem, sideoats grama, porcupinegrass, and switchgrass. If the plants are overgrazed or improperly harvested for hay, the plant community is mostly sideoats grama, tall dropseed, Kentucky bluegrass, and annual and perennial weeds. If overgrazing continues for many years, snowberry and buckbrush invade the plant community. The range condition can be improved or maintained by proper grazing use, timely deferment of grazing, and a grazing system that alternates grazing periods with rest periods and that includes a change in the order of these periods each year. Brush management and prescribed burning help to control woody plants. Range seeding can improve the stand.

This soil is poorly suited to the trees and shrubs grown as windbreaks and as plantings that enhance recreation areas or wildlife habitat. Adapted species have a fair chance of survival and growth. The soil absorbs and releases moisture too slowly, however, to sustain good tree growth. Drought, plant competition, and erosion are the principal hazards. Cultivating before planting helps to store moisture in the soil. Cultivating after planting helps to control competition from weeds. Conventional equipment can be used to cultivate between the tree rows, and rototilling or appropriate herbicides can be used in the rows. Planting the seedlings on the contour helps to control erosion.

Because of the slow permeability, this soil is not suited to septic tank absorption fields. It is suitable for sewage lagoons, but grading is required to modify the slope and to shape the lagoon. A high shrink-swell potential and the wetness are limitations on most sites for dwellings and small commercial buildings. Strengthening foundations and backfilling with coarse material help to prevent the structural damage caused by shrinking and swelling. On sites for dwellings with basements, a tile drainage system at the floor level carries away seepage water when the soil is saturated. Grading helps to keep surface runoff away from buildings. The design of small commercial buildings should accommodate the slope, or the site should be graded.

Low strength, frost action, and the high shrink-swell potential are limitations on sites for local roads and streets. The surface pavement and base material should be thick enough to compensate for the low strength of the soil. Providing coarser grained base material helps to ensure better performance. Grading and crowning the road and establishing adequate side ditches improve surface drainage and thus help to prevent the damage caused by frost action. Mixing the base material with additives, such as hydrated lime, helps to prevent excessive shrinking and swelling.

The capability units are IVe-4, dryland, and IVe-1, irrigated; Dense Clay range site; windbreak suitability group 4C.

MrD—Morrill clay loam, 5 to 11 percent slopes. This deep, strongly sloping, well drained soil is on uplands. It formed in glacial outwash material. Slopes are mostly convex and average about 8 percent. A few pebbles are on the surface. Areas range from 5 to 30 acres in size.

Typically, the surface layer is very dark gray, friable clay loam about 8 inches thick. The subsoil is about 40 inches thick. It is dark brown, friable clay loam in the upper part; dark reddish brown, friable clay loam in the next part; and brown, friable sandy clay loam in the lower part. The underlying material to a depth of more than 60 inches is strong brown fine sandy loam. In some areas, the subsoil is dark yellowish brown or yellowish brown. In some places, sandy loam or silt loam is at a depth of about 24 inches. In other places, the underlying material is clay or sand at a depth of 40 inches or more.

Included with this soil in mapping are small areas of Dickinson, Malcolm, and Mayberry soils. Dickinson soils have more sand than the Morrill soil, Malcolm soils have more silt, and Mayberry soils have more clay. All of these soils are in positions on the landscape similar to those of the Morrill soil. Also included are small areas of deep soils that have a surface layer of silty clay loam, small areas of gravelly soils, and small areas of soils that have many cobbles and stones on the surface. Included soils make up 2 to 15 percent of the unit.

Permeability is moderate in the Pawnee soil. Available water capacity is high; about 9 inches of water is available in the upper 60 inches. Organic matter content is moderate, or about 3 percent. The surface layer and the subsoil are slightly acid or medium acid. This soil dries readily after periods of rainfall and can be easily worked throughout a fairly wide range of moisture content.

About half of the acreage of this soil is cultivated. The rest is used for pasture or range.

If used for dryland farming, this soil is suited to grain sorghum, corn, wheat, soybeans, oats, alfalfa, and forage sorghum. Water erosion and loss of moisture through runoff are the principal hazards. Applying a system of conservation tillage that leaves all or part of the crop residue on the surface helps to control water erosion, increases the rate of water intake, and helps to maintain the content of organic matter and soil structure. Terraces, grassed waterways, and contour farming help to control runoff and water erosion. Row crops can be grown more frequently if these measures are applied. Maximum use of close-growing small grain, legumes, or legume-grass mixtures is effective in controlling water erosion. Timely tillage helps to prevent excessive compaction and preserves soil structure.

If irrigated, this soil is poorly suited to corn, grain sorghum, and soybeans. It is best suited to alfalfa and introduced grasses. Only sprinkler irrigation systems can be used because of the slope. Water erosion is the main hazard. It can be a problem in the wheel tracks if center-pivot irrigation systems are used. Terraces, contour farming, and grassed waterways are needed to control runoff and erosion. A cover of crops or crop residue also helps to control erosion. Adjusting the rate at which water is applied to the water intake rate of the soil helps to prevent excessive runoff and erosion. Timely application and efficient distribution of water are needed.

This soil is suited to introduced or domestic grasses for pasture. Pastures can be alternated with other crops as part of the crop rotation. Cool-season grasses, such as smooth brome or orchardgrass, are suited, either alone or in a mixture with a legume, such as alfalfa. Overgrazing causes low plant vigor and increases the likelihood that small gullies and rills will form during heavy rains. Separate pastures of cool- and warm-season grasses can be used to provide a long season of grazing. Rotation grazing and proper stocking rates help to keep the pasture in good condition. Nitrogen and phosphate fertilizers help to maintain the growth and vigor of the grasses.

This soil is suited to range and native hay. A cover of native grasses is effective in controlling water erosion. The natural plant community is mostly mid and tall grasses, such as big bluestem, indiangrass, little bluestem, porcupinegrass, sideoats grama, and switchgrass. If the plants are overgrazed or improperly harvested for hay, the plant community is mostly Kentucky bluegrass, sideoats grama, tall dropseed, and annual and perennial weeds. If overgrazing continues for many years, sumac, snowberry, and buckbrush invade the plant community. The range condition can be improved or maintained by proper grazing use, timely deferment of grazing, and a grazing system that alternates grazing periods with rest periods and that includes a change in the order of these periods each year. Brush management and prescribed burning help to control woody plants. Range seeding can improve the stand.

This soil is suited to the trees and shrubs grown as windbreaks and as plantings that enhance recreation areas or wildlife habitat. Adapted species survive and grow well. Plant competition and erosion are the principal hazards. Cultivating before planting helps to store moisture in the soil. Cultivation after planting helps to control competition from weeds. Rototilling or appropriate herbicides can be used in the tree rows. Planting the seedlings on the contour helps to control erosion.

The moderate permeability of this soil is a limitation on sites for septic tank absorption fields. It can be overcome by increasing the size of the absorption field. Land shaping and installing the absorption field on the contour help to ensure that the system operates properly. On sites for sewage lagoons, grading is required to modify the slope and to shape the lagoon. Lining or sealing the lagoon helps to prevent seepage. A moderate shrink-swell potential is a limitation on sites for dwellings and small commercial buildings. Strengthening foundations and backfilling with coarse material help to prevent the structural damage caused by shrinking and swelling. The design of dwellings and small commercial buildings should accommodate the slope, or the site should be graded.

The surface pavement and base material of local roads and streets should be thick enough to compensate for the low strength of this soil. Providing coarser grained base material helps to ensure better performance. A surface drainage system helps to prevent the damage caused by frost action. Crowning the road and establishing adequate side ditches help to drain the surface.

The capability units are IIIe-1, dryland, and IVe-3, irrigated; Silty range site; windbreak suitability group 3.

MrD2—Morrill clay loam, 5 to 11 percent slopes, eroded. This deep, strongly sloping, well drained soil is on uplands. It formed in glacial outwash. Except for those in small areas next to drainageways, slopes are plane or convex and average about 8 percent. Gravel is on the surface. Areas range from 5 to 50 acres in size.

Nearly all of the very dark original surface soil of this eroded soil has been removed. The surface layer is mostly the upper part of the original subsoil. Typically, it is dark brown, friable clay loam about 7 inches thick. The subsoil is about 41 inches thick. It is dark reddish brown, friable clay loam in the upper part; yellowish red, friable clay loam in the next part; and yellowish red, friable sandy clay loam in the lower part. The underlying material to a depth of more than 60 inches is brown and yellowish red sandy loam. In some places, the subsoil is yellowish or grayish brown. In other places, the surface layer and the upper part of the subsoil are silty clay loam. In some areas, the underlying material is loam or silt loam at a depth of 24 inches or more. In other areas, it is clay or sand at a depth of 40 inches or more. In some small areas, the slope is more than 11 percent.

Included with this soil in mapping are small areas of Dickinson and Mayberry soils. Dickinson soils have more sand throughout than the Morrill soil, and Mayberry soils have more clay in the subsoil. Both of these soils are in positions on the landscape similar to those of the Morrill soil. Also included are gumbo or scabby spots and some areas of gravelly soils. Included soils make up 2 to 15 percent of the unit.

Permeability is moderate in the Morrill soil. Available water capacity is high; about 9 inches of water is available in the upper 60 inches. Organic matter content is moderate, or about 2 percent. The surface layer and the subsoil are medium acid or slightly acid. The soil dries readily after periods of rainfall. Workability is good throughout a fairly wide range of moisture content.

About 65 percent of the acreage of this soil is cultivated. The rest has been reseeded to grass and used for pasture or range.

If used for dryland farming, this soil is poorly suited to grain sorghum, corn, wheat, soybeans, oats, alfalfa, and forage sorghum. Water erosion and loss of moisture through runoff are the principal hazards. Applying a system of conservation tillage that leaves all or part of the crop residue on the surface helps to control water erosion. Terracing and contour farming also help to control water erosion. Returning crop residue to the soil helps to maintain the organic matter content, improves soil structure, and increases the rate of water intake. Timely tillage helps to prevent excessive compaction and preserves soil structure. Grassed waterways carry water from fields at a nonerosive velocity. The soil can be protected by limited use of clean-cultivated row crops and maximum use of close-growing small grain, legumes, or legume-grass mixtures. Barnyard manure and commercial fertilizers improve fertility.

If irrigated, this soil is poorly suited to corn, grain sorghum, and soybeans. It is best suited to alfalfa and introduced grasses. Only sprinkler irrigation systems can be used because of the slope. Water erosion is the main hazard. It can be a problem in the wheel tracks if center-pivot irrigation systems are used. Terraces, contour farming, and grassed waterways are needed to control runoff and erosion. A cover of crops or crop residue also helps to control erosion. Adjusting the rate at which water is applied to the water intake rate of the soil helps to prevent excessive runoff and erosion. Timely application and efficient distribution of water are needed.

This soil is suited to introduced or domestic grasses for pasture. Pastures can be alternated with other crops as part of the crop rotation. Cool-season grasses, such as smooth brome or orchardgrass, are suited, either alone or in a mixture with a legume, such as alfalfa. Overgrazing causes low plant vigor and increases the likelihood that small gullies and rills will form during heavy rains. Separate pastures of cool- and warm-season grasses can be used to provide a long season of grazing. Rotation grazing and proper stocking rates help to keep the pasture in good condition. Nitrogen and phosphate fertilizers help to maintain the growth and vigor of the grasses.

This soil is suited to range and native hay. A cover of native grasses is effective in controlling water erosion. The natural plant community is mostly mid and tall grasses, such as big bluestem, indiangrass, little bluestem, porcupinegrass, sideoats grama, and switchgrass. If the plants are overgrazed or improperly harvested for hay, the plant community is mostly Kentucky bluegrass, sideoats grama, tall dropseed, and annual and perennial weeds. If overgrazing continues for many years, sumac, snowberry, and buckbrush invade the plant community. The range condition can be improved or maintained by proper grazing use, timely deferment of grazing, and a grazing system that alternates grazing periods with rest periods and that includes a change in the order of these periods each year. Brush management and prescribed burning help to control woody plants. Range seeding can improve the stand.

This soil is suited to the trees and shrubs grown as windbreaks and as plantings that enhance recreation areas or wildlife habitat. Adapted species survive and grow well. Plant competition and erosion are the principal hazards. Cultivating before and after planting helps to control competition from weeds. Rototilling or appropriate herbicides can be used in the tree rows. Planting the seedlings on the contour helps to control erosion.

The moderate permeability of this soil is a limitation on sites for septic tank absorption fields. It can be easily overcome by increasing the size of the absorption field. Land shaping and installing the absorption field on the contour help to ensure that the system operates

properly. On sites for sewage lagoons, grading is required to modify the slope and to shape the lagoon. A moderate shrink-swell potential is a limitation on sites for dwellings and small commercial buildings. Strengthening foundations and backfilling with coarse material help to prevent the structural damage caused by shrinking and swelling. Dwellings and other buildings should be designed to accommodate the slope, or the site should be graded to an acceptable gradient.

The surface pavement and base material of local roads and streets should be thick enough to compensate for the low strength of this soil. Providing coarser grained base material helps to ensure better performance. A surface drainage system helps to prevent the damage caused by frost action. Crowning the road and establishing adequate side ditches help to drain the surface. Cutting and filling generally are needed to provide a suitable grade.

The capability units are IVe-8, dryland, and IVe-3, irrigated; Silty range site; windbreak suitability group 3.

Na—Nishna silty clay, 0 to 1 percent slopes. This deep, nearly level, poorly drained soil is on bottom lands. It is occasionally flooded. It formed in clayey alluvium. Areas range from 20 to more than 100 acres in size.

Typically, the surface layer is very dark gray, firm silty clay about 4 inches thick. The subsurface layer is black, firm, calcareous silty clay about 32 inches thick. The subsoil is very dark gray, very firm, calcareous silty clay about 12 inches thick. The underlying material to a depth of more than 70 inches is very dark gray and dark gray, calcareous silty clay. In places, the subsurface layer is not calcareous.

Included with this soil in mapping are small areas of Kennebec, Nodaway, and Zoe soils. Kennebec and Nodaway soils are moderately well drained and are slightly higher on the landscape than the Nishna soil. Also, they have more silt and less clay. Zoe soils have alkaline salts and are in positions on the landscape similar to those of the Nishna soil. Also included are small marshes or very wet spots. Included areas make up 2 to 8 percent of the unit.

Permeability is slow in the Nishna soil. Available water capacity is moderate; about 7 inches of water is available in the upper 60 inches. Organic matter content is high, or about 5 percent. This soil is mildly alkaline or moderately alkaline in the surface layer and the subsurface layer. It dries slowly and stays wet in the winter and spring and during periods of continuous rainfall. A seasonal high water table is at a depth of 1 to 3 feet. The soil is difficult to work because it is sticky when wet, tough when moist, and very hard when dry. It can be worked only within a narrow range of moisture content.

Most of the acreage of this soil is cultivated. A few areas are used for pasture or range.

If used for dryland farming, this soil is suited to corn, grain sorghum, and soybeans. Flooding is a hazard, and wetness is the principal limitation. Because of the wetness in spring, adjustments in the planting dates and the crop varieties are necessary in most years. Flood-control structures are constructed in the upstream watershed. Diversions and dikes on the local flood plains can help to protect this soil from overflow. Surface drainage can be improved by arranging the rows of crops in a direction that conforms to the lay of the land and by grading and leveling. Filling in low areas helps to drain the surface. In places, surface ditching may be feasible. Drainage tile can be used where suitable outlets are available. The excessive compaction caused by tillage should be avoided, particularly when the soil is wet, because it further restricts the permeability.

If irrigated, this soil is suited to corn, grain sorghum, and soybeans. Gravity or sprinkler systems can be used. The wetness often delays tillage and cultivation in the spring. Adjustments in the planting dates and the crop varieties are necessary in most years. Land leveling improves surface drainage. It establishes a suitable grade for a uniform distribution of water in areas irrigated by a gravity system. Tile drains or open ditches can lower the water table where suitable outlets are available. Flooding can be controlled by diversion terraces on the local flood plains or by flood-control structures in the upstream watershed. Carefully controlling the rate and time of water application helps to achieve efficient water management.

This soil is suited to introduced or domestic grasses for pasture. Reed canarygrass and creeping foxtail are suitable species. Overgrazing or grazing during wet periods compacts the soil. Excessive wetness limits the choice of pasture grasses and legumes and makes seeding difficult. Grazing when the water table is highest damages the plants. Wetness can be reduced by land leveling and by tile drains or open ditches where suitable outlets are available. Rotation grazing and proper stocking rates help to keep the pasture in good condition. Nitrogen fertilizers help to maintain the growth and vigor of the grasses.

This soil is suited to range and native hay. The natural plant community is mostly mid and tall grasses, such as big bluestem, indiangrass, little bluestem, and switchgrass. If the plants are overgrazed or improperly harvested for hay, the plant community is mostly tall dropseed, Kentucky bluegrass, western wheatgrass, and many annual and perennial weeds. Snowberry and buckbrush invade the plant community. The range condition can be improved or maintained by proper grazing use, timely deferment of grazing, and a grazing system that alternates grazing periods with rest periods and that includes a change in the order of these periods each year. Brush management helps to control woody plants. Range seeding can improve the stand.

This soil is suited to the trees and shrubs that can withstand wetness. Seedlings generally survive and grow well. They are difficult to establish during wet years. Cultivating the soil with conventional equipment before and after planting and applying selected herbicides help to control weeds. In some years cultivating and planting are postponed because the soil is too wet.

Because of the flooding, the wetness, and the slow permeability, this soil is not suited to septic tank absorption fields. It is suited to sewage lagoons only if the site is diked or otherwise protected from flooding. The soil is not suitable as a site for buildings because of the flooding, the wetness, and the shrink-swell potential.

Constructing local roads on suitable, well compacted fill material above flood levels and establishing adequate side ditches and culverts help to prevent the damage caused by flooding and the seasonal high water table. The surface pavement and base material should be thick enough to compensate for the low strength of the soil. Providing coarser grained base material helps to ensure better performance. Mixing the base material with additives, such as hydrated lime, helps to prevent excessive shrinking and swelling.

The capability units are IIIw-1, dryland, and IIIw-1, irrigated; Clayey Overflow range site; windbreak suitability group 2W.

Nb—Nodaway silt loam, 0 to 1 percent slopes. This deep, nearly level, moderately well drained soil is on bottom lands. It is adjacent to deep stream channels and is occasionally flooded. It formed in stratified, silty alluvium. Areas are mostly long, continuous strips 25 to more than 100 acres in size.

Typically, the surface layer is very dark grayish brown, friable silt loam about 5 inches thick. The underlying material to a depth of 60 inches is dark gray, dark grayish brown, and very dark grayish brown, finely stratified silt loam. In some places, the underlying material is not stratified and is silty clay loam. In other places, the surface layer is silty clay loam or clay loam because of deposits that washed from the adjoining uplands. In some areas, the recent silty deposits are 24 or more inches deep over the original dark surface layer. In other areas, silty clay is below a depth of 40 inches.

Included with this soil in mapping are small areas of Kennebec and Zook soils. Kennebec soils are dark to a depth of more than 24 inches. Their positions on the landscape are similar to those of the Nodaway soil. The poorly drained Zook soils are lower on the landscape than the Nodaway soil. Also, they have more clay. Included soils make up 5 to 15 percent of the unit.

Permeability is moderate in the Nodaway soil. Available water capacity is high; about 13 inches of water is available in the upper 60 inches. Organic matter content is moderate, or about 3 percent. This soil is neutral throughout. A seasonal high water table is at a depth of 3 to 5 feet. In all areas except for the low areas that collect water, the soil dries readily after rains and can be worked throughout a wide range of moisture content.

About 75 percent of the acreage of this soil is cultivated. The rest is tracts of trees and grassed areas.

If used for dryland farming, this soil is suited to corn, grain sorghum, forage sorghum, soybeans, and oats. Row crops, such as corn, can be grown several years in succession, but weeds, plant diseases, and insects should be controlled (fig. 5). The occasional flooding is the principal hazard. In places it can be controlled by diversions and dikes on the local flood plain. Land grading and leveling improve surface drainage. Returning crop residue to the soil increases the rate of water intake and helps to maintain the organic matter content. Delaying tillage when the soil is too wet helps to prevent excessive compaction.

If irrigated, this soil is suited to corn, grain sorghum, and soybeans. Gravity or sprinkler systems can be used. Diversions, dikes, and conservation practices on the adjacent soils reduce the risks of flooding and crop damage on this soil. Land leveling improves surface drainage and establishes a suitable grade for the uniform distribution of water in areas irrigated by a gravity system. Carefully controlling the rate and time of water application helps to achieve efficient water management. Returning crop residue to the soil increases the rate of water intake and helps to maintain the organic matter content.

This soil is suited to introduced or domestic grasses for pasture. Cool-season grasses, such as smooth brome and orchardgrass, are suited, either alone or in a mixture with a legume, such as alfalfa or trefoil. Deposition of silt and overgrazing reduce the vigor and retard the growth of the grasses. Grazing should be delayed in the spring until after the surface is firm and the grasses have reached a minimum height of 5 or 6 inches. Rotation grazing and proper stocking rates help to keep the pasture in good condition. Nitrogen fertilizers help to maintain the growth and vigor of the grasses. Weeds can be controlled by spraying with appropriate herbicides.

This soil is suited to range and native hay. The natural plant community is mostly mid and tall grasses, such as big bluestem, little bluestem, and switchgrass, and grasslike plants, such as various sedges. If the plants are overgrazed or improperly harvested for hay, the plant community is mostly Kentucky bluegrass, sedges, and many annual and perennial weeds. Snowberry and buckbrush are woody plants that invade the plant community. The range condition can be improved or maintained by proper grazing use, timely deferment of grazing, and a grazing system that alternates grazing periods with rest periods and that includes a change in the order of these periods each year. Brush management helps to control the woody plants. Range seeding can improve the stand.

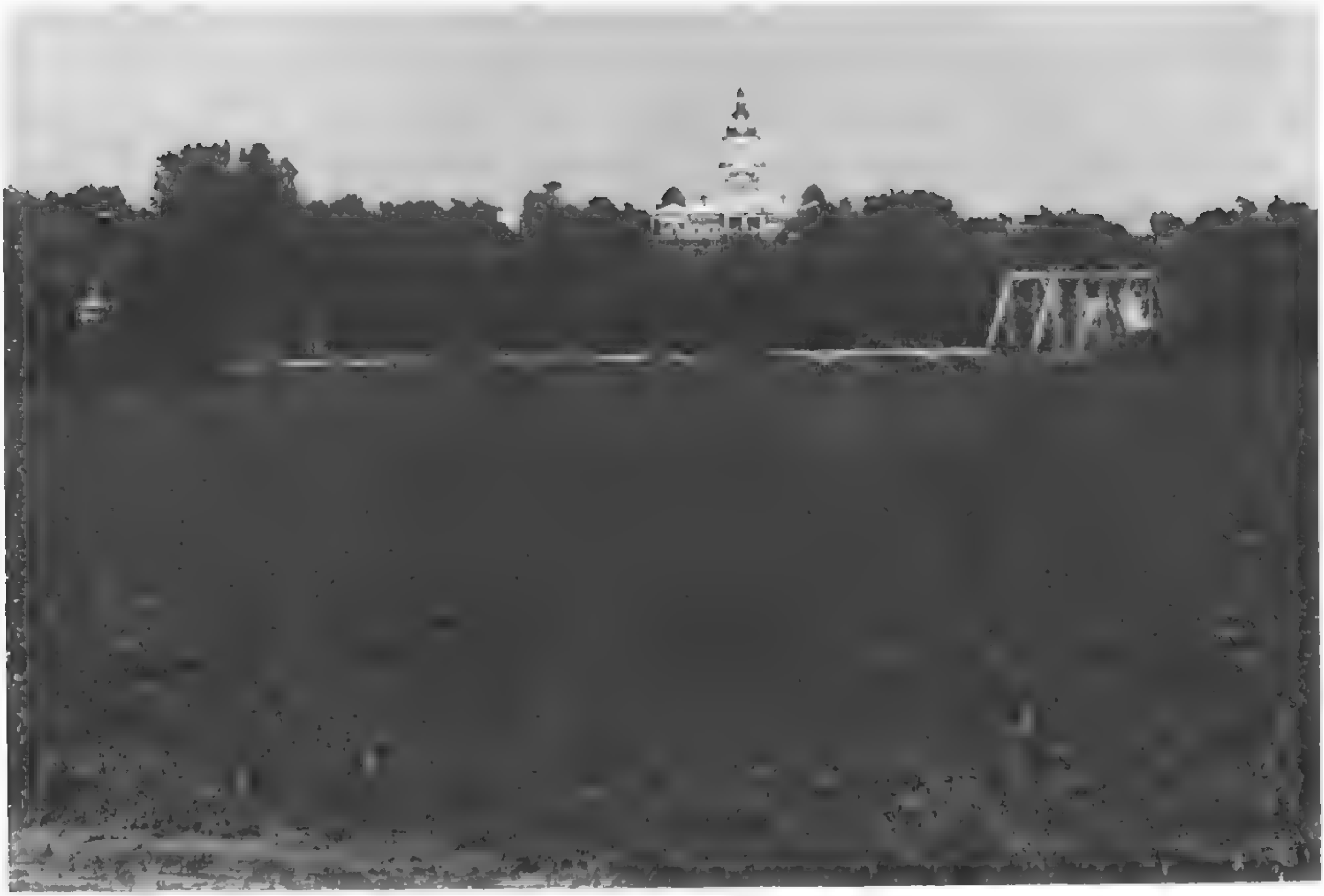


Figure 5.—Corn in an area of Nodaway silt loam, 0 to 1 percent slopes. The county courthouse is in the background.

This soil is suited to the trees and shrubs grown as windbreaks and as plantings that enhance recreation areas or wildlife habitat. Seedlings generally survive and grow well if moisture is conserved and weedy vegetation is removed. Weeds and grasses can be controlled by cultivating between the tree rows with conventional equipment and by rototilling and applying herbicides in the rows.

This soil is suited to ash, black walnut, and other trees used for wood products. Naturally wooded areas can be improved by restricting grazing, by removing the less desirable and poorly formed trees, by supplemental planting, and by pruning. These areas provide habitat for wildlife.

Because of the flooding, this soil is not suitable as a site for buildings or septic tank absorption fields. The flooding also is a hazard on sites for sewage lagoons. It can be controlled by diking the lagoon.

Local roads and streets should be constructed on suitable, well compacted fill material above flood levels. Side ditches and culverts help to prevent the damage caused by floodwater. A surface drainage system helps to prevent the damage caused by frost action. Crowning the road and establishing adequate side ditches help to drain the surface. The surface pavement and base material should be thick enough to compensate for the low strength of the soil. Providing coarser grained base material helps to ensure better performance.

The capability units are IIw-3, dryland, and IIw-6, irrigated; Silty Overflow range site; windbreak suitability group 1.

Nf—Nodaway silt loam, channeled. This deep, nearly level, moderately well drained soil is on bottom lands. It has many entrenched, meandering stream channels, and it is frequently flooded. It formed in silty

alluvium. Areas are long, narrow, and irregular in shape and range from 10 to more than 100 acres in size.

Typically, the surface layer is very dark grayish brown, friable silt loam about 5 inches thick. The underlying material to a depth of about 60 inches is silt loam. The upper part is very dark grayish brown, dark grayish brown, grayish brown, and pale brown and is finely stratified, and the lower part is very dark gray and dark gray. In some places, the soil is not finely stratified. In other places, some strata are sandy.

Included with this soil in mapping are areas of old stream channels, some of which are now intermittent ponds. Also included are some areas of short, steep, uneven slopes along the edges of the channels and areas of steep slopes on the adjacent uplands. Included areas make up 5 to 15 percent of the unit.

Permeability is moderate in the Nodaway soil. Available water capacity is high. Organic matter content is moderate. The seasonal high water table is at a depth of 3 to 5 feet. This soil dries readily after rains.

Most of the acreage of this soil is wooded or supports grass and is used for pasture or wildlife habitat. A few areas are used for range.

Because of flooding, this soil is generally not suited to cultivated crops. The meandering stream channels limit the access and use of farm machines. The soil is suited to introduced or domestic grasses for pasture. Woody plants commonly compete with the grasses. Cool-season grasses, such as smooth brome or orchardgrass, are suited, either alone or in a mixture with legumes, such as alfalfa or trefoil. In some areas, sediment deposited by floodwater partly covers the grasses and reduces vigor and growth. Flooding also is a hazard to livestock. Proper stocking rates help to keep the pasture in good condition.

This soil is suited to range. The natural plant community is mostly mid and tall grasses, such as big bluestem, little bluestem, switchgrass, and grasslike plants, such as different species of the sedge family. If the plants are overgrazed, the plant community is mostly Kentucky bluegrass, sedges, and many annual and perennial weeds. Snowberry and buckbrush invade the plant community. The range condition can be improved or maintained by proper grazing use, timely deferment of grazing, and a grazing system that alternates grazing periods with rest periods and that includes a change in the order of these periods each year. Brush management and prescribed burning help to control the woody plants.

Few trees and shrubs are planted as windbreaks on this soil. The soil is generally not suited to this use because of the meandering channels and the narrow mapped areas. Trees have a good chance of survival and growth if plant competition is not excessive. Planting, spraying, and tilling can be done by hand or with small garden implements.

This soil is suited to high-value trees, such as black walnut and other species used for wood products. Naturally wooded areas can be improved by restricting grazing, by removing the less desirable and poorly formed trees, by supplemental planting, and by pruning. The soil provides habitat for deer, bobwhite quail, squirrels, cottontail rabbit, songbirds, and other wildlife. Beaver, mink, muskrat, and raccoon are furbearers that live near the streams.

Because of flooding, this soil is not suitable as a site for buildings or sanitary facilities. Constructing roads on suitable, well compacted fill material above flood levels and establishing adequate side ditches and culverts help to prevent the damage caused by floodwater. A surface drainage system helps to prevent the damage caused by frost action. Crowning the road and establishing adequate side ditches help to drain the surface. The surface pavement and base material should be thick enough to compensate for the low strength of the soil. Providing coarser grained base material helps to ensure better performance.

The capability unit is VIw-7, dryland; Silty Overflow range site; windbreak suitability group 10.

PaC—Pawnee clay loam, 3 to 9 percent slopes. This deep, gently sloping and strongly sloping, moderately well drained soil is on knolls and side slopes in the uplands. It formed in glacial till. Except those in areas adjacent to drainageways, slopes are convex and average about 7 percent. Areas are irregular in shape and range from about 5 to 80 acres in size.

Typically, the surface layer is very dark brown, friable clay loam about 12 inches thick. The subsoil is about 45 inches thick. It is very dark grayish brown, firm clay in the upper part; dark grayish brown and grayish brown, mottled very firm clay in the next part; and light brownish gray, mottled firm clay loam in the lower part. The underlying material to a depth of more than 70 inches is light brownish gray, mottled, calcareous clay loam. In some areas, the surface layer is silty clay loam or silt loam. In other areas, the upper part of the subsoil is dark grayish brown silty clay. In some areas on the lower slopes, the soil is dark to a depth of 24 inches or more. In places, the upper part of the subsoil is dark reddish brown.

Included with this soil in mapping are small areas of Burchard, Shelby, and Judson soils. Burchard and Shelby soils have less clay in the subsoil than the Pawnee soil. Also, they are in steeper, lower areas. Judson soils have less clay than the Pawnee soil, are siltier throughout, and have a thick, dark surface layer. They are on foot slopes. Included soils make up 2 to 12 percent of the unit.

Permeability is slow in the Pawnee soil. Available water capacity is moderate; about 8 inches of water is available in the upper 60 inches. Organic matter content is moderate, or about 4 percent. The surface layer and

the upper part of the subsoil are slightly acid or medium acid. A perched seasonal high water table is at a depth of 1 to 3 feet in the spring. This soil dries slowly and stays wet during prolonged periods of rainfall. Workability is fairly good only during periods of optimum moisture. The soil releases moisture slowly to plants.

About 40 percent of the acreage of this soil is cultivated. The rest is used for pasture or range.

If used for dryland farming, this soil is suited to grain sorghum, wheat, corn, soybeans, oats, forage sorghum, and alfalfa. Because of the moderate available moisture capacity, it is best suited to cool-season small grain, such as wheat, or to drought-resistant crops, such as sorghum. Water erosion is the major hazard. Loss of soil nutrients and of soil moisture through runoff is a management concern. Applying a system of conservation tillage and returning crop residue to the soil increase the rate of water intake, reduce the evaporation rate, help to maintain the content of organic matter, and reduce the susceptibility to water erosion. The excessive compaction caused by tillage should be avoided, particularly when the soil is wet, because it further restricts permeability. Timely tillage minimizes compaction and helps to preserve soil structure. Terraces, grassed waterways, and contour farming help to control runoff and erosion. Row crops can be used more frequently if these measures are applied. This soil can be protected by limiting the use of clean-cultivated row crops and by making maximum use of close-growing small grain, legumes, or legume-grass mixtures. Legumes in the cropping sequence add nitrogen to the soil and help to maintain soil structure and soil porosity.

If irrigated, this soil is poorly suited to corn, grain sorghum, and soybeans. It is best suited to alfalfa and introduced grasses. Only sprinkler irrigation systems are suited because of the slope. Water erosion is the main hazard. It can be a problem in the wheel tracks if center-pivot irrigation systems are used. Terraces, contour farming, and grassed waterways are needed to control runoff and erosion. A cover of crops or crop residue also helps to control erosion. Adjusting the rate at which water is applied to the water intake rate of the soil helps to prevent excessive runoff and erosion. Timely application and efficient distribution of water are needed.

This soil is suited to introduced or domestic grasses for pasture. Pastures can be alternated with other crops as part of the crop rotation. Cool-season grasses, such as smooth brome or orchardgrass, are suited, either alone or in a mixture with a legume, such as alfalfa. Overgrazing or grazing during wet periods compacts the soil. Overgrazing also causes low plant vigor and increases the likelihood that small gullies and rills will form during heavy rains. Separate pastures of cool- and warm-season grasses can be used to provide a long season of grazing. Rotation grazing and proper stocking rates help to keep the pasture in good condition. Nitrogen fertilizers help to maintain the growth and vigor of the grasses.

This soil is suited to range and native hay. A cover of native grasses is effective in controlling water erosion. The natural plant community is mostly mid and tall grasses, such as big bluestem, indiangrass, little bluestem, porcupinegrass, and switchgrass. If the plants are overgrazed or improperly harvested for hay, the plant community is mostly sideoats grama, tall dropseed, Kentucky bluegrass, and annual and perennial weeds. If overgrazing continues for many years, sumac, snowberry, and buckbrush invade the plant community. The range condition can be improved or maintained by proper grazing use, timely deferment of grazing, and a grazing system that alternates grazing periods with rest periods and that includes a change in the order of these periods each year. Brush management and prescribed burning help to control the woody plants. Range seeding can improve the stand.

This soil is poorly suited to the trees and shrubs grown as windbreaks and as plantings that enhance recreation areas or wildlife habitat. Adapted species have a fair chance of survival and growth. The soil absorbs and releases moisture too slowly, however, to sustain good tree growth. Drought, plant competition, and erosion are the principal hazards. Cultivating before planting helps to store moisture in the soil. Cultivating after planting helps to control competition from weeds. Conventional equipment can be used to cultivate between the tree rows, and rototillers or appropriate herbicides can be used in the rows. Planting on the contour helps to control erosion.

Because of the slow permeability, this soil is not suited to septic tank absorption fields. A suitable alternative site or method is needed. The soil is suitable as a site for sewage lagoons, but grading is required to modify the slope and shape the lagoon. A high shrink-swell potential and the wetness are limitations on sites for dwellings and small commercial buildings. Strengthening foundations and backfilling with coarse material help to prevent the structural damage caused by shrinking and swelling. On sites for dwellings with basements, a tile drainage system at the floor level carries away seepage water when the soil becomes saturated. A suitable outlet is needed. Grading helps to keep surface runoff away from buildings.

Low strength, frost action, and shrinking and swelling are limitations on sites for local roads and streets. The surface pavement and base material should be thick enough to compensate for the low strength of this soil. Providing coarser grained base material helps to ensure better performance. Grading and crowning the road and establishing adequate side ditches improve surface drainage and thus help to prevent the damage caused by frost action. Mixing the base material with additives, such as hydrated lime, helps to prevent excessive shrinking and swelling.

The capability units are IIIe-2, dryland, and IVe-1, irrigated; Clayey range site; windbreak suitability group 4C.

PaD—Pawnee clay loam, 9 to 12 percent slopes. This deep, moderately steep, moderately well drained soil is on side slopes in the uplands. It formed in glacial till. Slopes are mostly convex and average about 11 percent. Areas range from 5 to 35 acres in size.

Typically, the surface layer is black, friable clay loam about 7 inches thick. The subsurface layer is very dark gray, friable clay loam about 6 inches thick. The subsoil is about 38 inches thick. It is very dark grayish brown, firm clay loam in the upper part; dark grayish brown, mottled, very firm clay in the next part; and grayish brown, mottled, very firm clay in the lower part. The underlying material to a depth of more than 60 inches is brown, mottled clay loam. In some places, the subsoil is silty clay. In other places, it is dark reddish brown in the upper part. In some areas on the lower part of the slopes and adjacent to drainageways, the soil is dark to a depth of more than 24 inches. In places, the underlying material is stratified silt loam, silty clay, or clay and sand.

Included with this soil in mapping are small areas of Malcolm, Morrill, and Shelby soils. These soils have less clay in the subsoil than the Pawnee soil. They are in positions on the landscape similar to those of the Pawnee soil. They make up 2 to 10 percent of the unit.

Permeability is slow in the Pawnee soil. Available water capacity is moderate; about 8 inches of water is available in the upper 60 inches. Organic matter content is moderate, about 4 percent. The surface layer and the upper part of the subsoil are slightly acid or medium acid. This soil dries slowly and stays wet during prolonged periods of rain. A perched seasonal high water table is at a depth of 1 to 3 feet in the spring. Workability is fair only during periods of optimum moisture content.

Most of the acreage of this soil is used for pasture or range. A few areas are cultivated.

Because of the moderately steep slope and a severe hazard of water erosion, this soil is generally unsuitable for irrigated crops and grasses. It is poorly suited to dryland crops. Because of the moderate available water capacity, it is best suited to cool-season small grain, such as oats and wheat. A cover of close-growing small grain and legumes helps to control erosion. Applying a system of conservation tillage and returning crop residue to the soil help to control water erosion and reduce the evaporation rate. If clean-cultivated row crops are grown, terraces, contour farming, and grassed waterways are necessary to control water erosion.

This soil is suited to introduced or domestic grasses for pasture. Cool-season grasses, such as smooth brome and orchardgrass, are suited, either alone or in a mixture with a legume, such as alfalfa. Overgrazing causes low plant vigor and increases the likelihood that small gullies and rills will form during heavy rains. Rotation grazing and proper stocking rates help to keep the pasture in good condition. Nitrogen fertilizers help to maintain the growth and vigor of the grasses.

This soil is suited to range and native hay. A cover of native grasses is effective in controlling water erosion. The natural plant community is mostly mid and tall grasses, such as big bluestem, indiangrass, little bluestem, porcupinegrass, and switchgrass. If the plants are overgrazed or improperly harvested for hay, the plant community is mostly sideoats grama, tall dropseed, Kentucky bluegrass, and annual and perennial weeds. If overgrazing continues for many years, sumac, snowberry, and buckbrush invade the plant community. The range condition can be improved or maintained by proper grazing use, timely deferment of grazing, and a grazing system that alternates grazing periods with rest periods and that includes a change in the order of these periods each year. Brush management and prescribed burning help to control the woody plants. Range seeding can improve the stand.

This soil is poorly suited to the trees and shrubs grown as windbreaks and as plantings that enhance recreation areas or wildlife habitat. Adapted species have a fair chance of survival and growth. The soil absorbs and releases moisture too slowly, however, to sustain good tree growth. Drought, plant competition, and erosion are the principal hazards. Cultivating before planting helps to store moisture in the soil. Cultivating after planting helps to control competition from weeds. Conventional equipment can be used to cultivate between the tree rows, and rototillers or appropriate herbicides can be used in the rows. Planting on the contour helps to control erosion.

Because of the slow permeability, this soil is not suited to septic tank absorption fields. A suitable alternative site is needed. The slope is a limitation on sites for sewage lagoons. On sites for small lagoons, cutting and filling can modify the slope. Otherwise, an alternative site should be selected. A high shrink-swell potential and the wetness are limitations on sites for dwellings and small commercial buildings. Strengthening foundations and backfilling with coarse material help to prevent the structural damage caused by shrinking and swelling. On sites for dwellings with basements, a tile drainage system at the floor level carries away seepage water when the soil is saturated. Grading helps to keep surface runoff away from the buildings. The design of small commercial buildings should accommodate the slope, or the site should be graded.

The surface pavement and base material of local roads and streets should be thick enough to compensate for the low strength of this soil. Providing coarser grained base material helps to ensure better performance. A surface drainage system helps to prevent the damage caused by frost action. Crowning the road and

establishing adequate side ditches help to drain the surface. Mixing the base material with additives, such as hydrated lime, helps to prevent excessive shrinking and swelling.

The capability unit is IVe-2, dryland; Clayey range site; windbreak suitability group 4C.

PbC2—Pawnee clay, 3 to 9 percent slopes, eroded. This deep, gently sloping and strongly sloping, moderately well drained soil is on knolls, side slopes, and ridgetops in the uplands. It formed in glacial till. Except for those in areas next to drainageways, slopes are convex and average about 7 percent. Pebbles and cobblestones are common on the surface. Areas range from 5 to more than 150 acres in size.

Nearly all of the very dark original surface soil of this eroded soil has been removed. The surface layer is mostly subsoil material. Typically, it is dark brown, firm clay about 7 inches thick. The subsoil is very firm, mottled clay about 31 inches thick. The upper part is dark grayish brown, the next part is yellowish brown, and the lower part is grayish brown. The underlying material to a depth of more than 60 inches is grayish brown, mottled, calcareous clay loam. In small areas next to drainageways, the surface layer is thicker and darker. In places, it is silty clay loam or silty clay. In some areas, the upper part of the subsoil is dark reddish brown or reddish brown.

Included with this soil in mapping are small areas of Burchard, Shelby, and Judson soils. Burchard and Shelby soils have less clay than the Pawnee soil. Also, they are in steeper, lower areas. Judson soils are dark to a depth of more than 24 inches. They are on foot slopes. Included soils make up 2 to 10 percent of the unit.

Permeability is slow in the Pawnee soil. Available water capacity is moderate; about 8 inches of water is available in the upper 60 inches. Organic matter content is moderate, or about 2 percent. The surface layer is slightly acid, and the subsoil is neutral. A perched seasonal high water table is at a depth of 1 to 3 feet in spring. This soil dries slowly and stays wet during prolonged periods of rainfall. Workability is fair only during periods of optimum moisture. The soil is sticky when wet, firm or very firm when moist, and very hard when dry. It releases moisture slowly to plants. Large cracks form as the soil dries.

About 60 percent of the acreage of this soil is cultivated. The rest is used for range or grass that has been reseeded.

If used for dryland farming, this soil is poorly suited to cultivated crops. Because of the moderate available water capacity, it is best suited to cool-season small grain, such as oats and wheat, or to drought-resistant crops, such as grain sorghum and forage sorghum. Water erosion is the major hazard. Other management concerns are conserving moisture and maintaining the organic matter content, the fertility level, and the workability of the soil. If the soil is used for continuous row crops, erosion is difficult to control. Applying a system of conservation tillage and returning crop residue to the soil increase the rate of water intake, reduce the evaporation rate, add organic matter, and reduce the susceptibility to water erosion. The excessive compaction caused by tillage should be avoided, particularly when the soil is wet, because it further restricts permeability. Timely tillage minimizes compaction and helps to preserve soil structure. Terracing and contour farming help to control erosion. Grassed waterways carry water from fields at a nonerosive velocity. The soil can be protected by limited use of clean-cultivated row crops and by maximum use of close-growing small grain, legumes, or legume-grass mixtures. Barnyard manure and commercial fertilizers improve fertility.

If irrigated, this soil is poorly suited to corn, grain sorghum, and soybeans. It is best suited to alfalfa and introduced grasses. Only sprinkler irrigation systems are suited because of the slope. Water erosion is the main hazard. It can be a problem in the wheel tracks if center-pivot irrigation systems are used. Terraces, contour farming, and grassed waterways are needed to control runoff and erosion. A cover of crops or crop residue also helps to control erosion. Adjusting the rate at which water is applied to the water intake rate of the soil helps to prevent excessive runoff and erosion. Timely application and efficient distribution of water are needed.

This soil is suited to introduced or domestic grasses for pasture. Pastures can be alternated with other crops as part of the crop rotation. Cool grasses, such as smooth brome or orchardgrass, are suited, either alone or in a mixture with a legume, such as alfalfa. Overgrazing or grazing during wet periods compacts the soil. Overgrazing also causes low plant vigor and increases the likelihood that small gullies and rills will form during heavy rains. Separate pastures of cool- and warm-season grasses can be used to provide a long season of grazing. Rotation grazing and proper stocking rates help to keep the pasture in good condition. Nitrogen and phosphate fertilizers help to maintain the growth and vigor of the grasses.

This soil is suited to range and native hay. A cover of native grasses is effective in controlling water erosion. The natural plant community is mostly big bluestem, indiangrass, little bluestem, sideoats grama, porcupinegrass, and switchgrass. If the plants are overgrazed or improperly harvested for hay, the plant community is mostly sideoats grama, tall dropseed, Kentucky bluegrass, and annual and perennial weeds. If overgrazing continues for many years, snowberry and buckbrush invade the plant community. The range condition can be improved or maintained by proper grazing use, timely deferment of grazing, and a grazing system that alternates grazing periods with rest periods

and that includes a change in the order of these periods each year. Brush management and prescribed burning help to control the woody plants. Range seeding can improve the stand.

This soil is poorly suited to the trees and shrubs grown as windbreaks and as plantings that enhance recreation areas or wildlife habitat. Adapted species have a fair chance of survival and growth. The soil absorbs and releases moisture too slowly, however, to sustain good tree growth. Drought, plant competition, and erosion are the principal hazards. Cultivating before planting helps to store moisture in the soil. Cultivating after planting helps to control competition from weeds. Conventional equipment can be used to cultivate between the tree rows, and rototillers or appropriate herbicides can be used within the rows. Planting on the contour helps to control erosion.

Because of the slow permeability, this soil is not suited to septic tank absorption fields. It is suitable for sewage lagoons, but grading is required to modify the slope and to shape the lagoon. A high shrink-swell potential and the wetness are limitations on most sites for dwellings and small commercial buildings. Strengthening foundations and backfilling with coarse material help to prevent the structural damage caused by shrinking and swelling. On sites for dwellings with basements, a tile drainage system at the floor level carries away seepage water when the soil becomes saturated. Grading helps to keep surface runoff away from the buildings.

Low strength, frost action, and shrinking and swelling are limitations on sites for local roads and streets. The surface pavement and base material should be thick enough to compensate for the low strength of this soil. Providing coarser grained base material helps to ensure better performance. Grading and crowning the road and establishing adequate side ditches improve surface drainage and thus help to prevent the damage caused by frost action. Mixing the base material with additives, such as hydrated lime, helps to prevent excessive shrinking and swelling.

The capability units are IVe-4, dryland, and IVe-1, irrigated; Dense Clay range site; windbreak suitability group 4C.

PbD2—Pawnee clay, 9 to 12 percent slopes, eroded. This deep, moderately steep, moderately well drained soil is on uplands. It formed in glacial till. Slopes are mostly convex and average about 11 percent. In most places, pebbles and cobblestones are on the surface. Areas are irregular in shape and range from about 5 to 25 acres in size.

Nearly all of the very dark original surface soil of this eroded soil has been removed. The surface layer is mostly subsoil material. Typically, it is very dark grayish brown, firm clay about 8 inches thick. The subsoil is mottled clay about 29 inches thick. The upper part is dark grayish brown and very firm, and the lower part is brown and firm. The underlying material to a depth of more than 60 inches is light brownish gray, mottled, calcareous clay loam. In places, the subsoil is dark reddish brown or reddish brown. In some areas on the lower slopes, the soil is dark to a depth of 20 inches or more. In some areas, the underlying material is stratified silt loam, silty clay, or clay and sand.

Included with this soil in mapping are small areas of Malcolm, Morrill, and Shelby soils. These soils have less clay than the Pawnee soil. They are in positions on the landscape similar to those of the Pawnee soil. Also included are deeply entrenched drainageways that have short, steep slopes. Included areas make up 5 to 20 percent of the unit.

Permeability is slow in the Pawnee soil. Available water capacity is moderate. Organic matter content also is moderate. The surface layer is slightly acid, and the subsoil is neutral. This soil dries slowly and stays wet during prolonged periods of rainfall. A perched seasonal high water table is at a depth of 1 to 3 feet in the spring. Workability is fair only during periods of optimum moisture. The soil is sticky when wet, firm when moist, and very hard when dry. Large cracks form as the soil dries.

Most of the acreage of this soil has been reseeded to grass and is used for pasture or range. A few small areas support trees.

This soil is not suited to cultivation. The slope is the principal limitation. Runoff is rapid and water erosion severe if the soil is cultivated.

This soil is suited to range and native hay. A cover of native grasses is effective in controlling water erosion. The natural plant community is mostly mid and tall grasses, such as big bluestem, indiangrass, little bluestem, sideoats grama, porcupinegrass, and switchgrass. If the plants are overgrazed or improperly harvested for hay, the plant community is mostly sideoats grama, tall dropseed, Kentucky bluegrass, and annual and perennial weeds. If overgrazing continues for many years, snowberry and buckbrush invade the plant community. The range condition can be improved or maintained by proper grazing use, timely deferment of grazing, and a grazing system that alternates grazing periods with rest periods and that includes a change in the order of these periods each year. Brush management and prescribed burning help to control the woody plants. Range seeding can improve the stand.

This soil is poorly suited to the trees and shrubs grown as windbreaks and as plantings that enhance recreation areas or wildlife habitat. Adapted species have a fair chance of survival and growth. The soil absorbs and releases moisture too slowly, however, to sustain good tree growth. Drought, plant competition, and erosion are the principal hazards. Cultivating before planting helps to store moisture in the soil. Cultivating after planting helps to control competition from weeds. Conventional equipment can be used to cultivate between the tree

rows, and rototillers or appropriate herbicides can be used in the rows. Planting on the contour helps to control erosion.

Because of the slow permeability, this soil is not suited to septic tank absorption fields. A suitable alternative site or disposal method generally is needed. On sites for small sewage lagoons, cutting and filling can modify the slope. Otherwise, an alternative site should be selected. A high shrink-swell potential and the wetness are limitations on sites for dwellings and small commercial buildings. Strengthening foundations and backfilling with coarse material help to prevent the structural damage caused by shrinking and swelling. On sites for dwellings with basements, a tile drainage system at the floor level carries away seepage water when the soil becomes saturated. A suitable tile outlet and grading help to keep surface runoff away from the buildings. The design of small commercial buildings should accommodate the slope, or the site should be graded.

The surface pavement and base material of local roads and streets should be thick enough to compensate for the low strength of this soil. Providing coarser grained base material helps to ensure better performance. A surface drainage system helps to prevent the damage caused by frost action. Crowning the road by grading and establishing adequate side ditches help to drain the surface. Mixing the base material with additives, such as hydrated lime, helps to prevent excessive shrinking and swelling.

The capability unit is VIe-4, dryland; Dense Clay range site; windbreak suitability group 4C.

ShB—Sharpsburg silty clay loam, 1 to 4 percent slopes. This deep, very gently sloping, moderately well drained soil is on ridgetops in the uplands. It formed in loess. Areas are irregular in shape and range from 10 to about 50 acres in size.

Typically, the surface layer is very dark grayish brown, friable silty clay loam about 6 inches thick. The subsurface layer also is very dark grayish brown, friable silty clay loam. It is about 5 inches thick. The subsoil is silty clay loam about 46 inches thick. The upper part is dark brown and firm, and the lower part is yellowish brown, mottled, and friable. The underlying material to a depth of more than 70 inches is yellowish brown, mottled silty clay loam.

Permeability is moderately slow. Available water capacity is high; about 12 inches of water is available in the upper 60 inches. Organic matter content is moderate, or about 3 percent. The surface layer and the upper part of the subsoil are medium acid or slightly acid. This soil dries readily after rains and can be easily worked throughout a fairly wide range of moisture content.

Nearly all of the acreage is cultivated. If used for dryland farming, this soil is suited to corn, soybeans, grain sorghum, wheat, oats, alfalfa, clover, and grasses. Row crops, such as corn and soybeans, can be grown several years in succession, but weeds, insects, and plant diseases should be controlled. Water erosion and loss of moisture through runoff are the principal hazards. These hazards can be reduced by conservation tillage and contour farming. Returning crop residue to the soil increases the rate of water intake and helps to maintain the content of organic matter. Timely tillage minimizes compaction and helps to maintain soil structure. Terraces can be used to protect the soil from concentrated runoff.

If irrigated, this soil is suited to corn, grain sorghum, and soybeans. Runoff and water erosion are the principal hazards. Conservation tillage practices, such as chiseling or disking, that leave all or part of the crop residue on the surface help to control water erosion. Adjusting the rate at which water is applied to the water intake rate of the soil helps to prevent excessive runoff and erosion. Terraces also help to control erosion.

Gravity or sprinkler irrigation systems can be used on this soil. Less land preparation is needed if a sprinkler system is used. Timely application and efficient distribution of water are needed. A proper grade is needed in areas irrigated by a gravity system. This commonly can be achieved by land leveling. Areas deeply cut by land leveling are deficient in organic matter, nitrogen, phosphorus, and zinc.

This soil is suited to the trees and shrubs grown as windbreaks and as plantings that enhance recreation areas or wildlife habitat. Seedlings of adapted species survive and grow well if moisture is conserved and weeds are controlled. Erosion is a minor hazard. Cultivating between the rows with conventional equipment helps to store moisture in the soil and controls weeds and grasses. Rototillers or appropriate herbicides can be used within the rows. Planting on the contour helps to control erosion.

The moderately slow permeability limits this soil as a site for septic tank absorption fields. This limitation can be overcome by increasing the size of the absorption field. The soil is suitable for sewage lagoons, but grading is required to modify the slope and to shape the lagoon. Lining the lagoon with less permeable material helps to prevent seepage. A moderate shrink-swell potential is the only limitation on sites for dwellings and small commercial buildings. Strengthening foundations and backfilling with coarse material help to prevent the structural damage caused by shrinking and swelling.

A surface drainage system helps to prevent the damage to roads and streets caused by frost action. Crowning the road by grading and establishing adequate side ditches help to drain the surface. The surface pavement and base material should be thick enough to compensate for the low strength of this soil. Providing coarser grained base material helps to ensure better performance.

The capability units are IIe-1, dryland, and IIIe-3, irrigated; Silty range site; windbreak suitability group 3.

SkE—Shelby clay loam, 9 to 15 percent slopes. This deep, moderately steep, well drained soil is on uplands. It formed in glacial till. Slopes are convex on knolls and plane or concave next to drainageways. They average about 11 percent. Pebbles, cobblestones, and a few scattered boulders are on the surface. Areas range from about 5 to 80 acres in size.

Typically, the surface layer is very dark grayish brown, friable clay loam about 8 inches thick. The subsurface layer is very dark gray, friable clay loam about 7 inches thick. The subsoil is clay loam about 36 inches thick. The upper part is mixed very dark grayish brown and dark yellowish brown, the next part is yellowish brown, and the lower part is mottled pale brown and strong brown. The underlying material to a depth of more than 70 inches is mixed light brownish gray, yellowish brown, and strong brown, calcareous clay loam. In several areas on convex knolls, lime is at a depth of 10 to 24 inches. In some places, the subsoil is more grayish or reddish. In other places, it is loam. In some areas, the surface layer is sandy loam

Included with this soil in mapping are small areas of gravelly, stony, or bouldery soils. Also included are small areas of Dickinson, Judson, Malcolm, Pawnee, and Steinauer soils. Dickinson soils formed in loamy and sandy material. Judson soils are dark to a depth of more than 24 inches. Malcolm soils formed in silty deposits. Pawnee soils have a clay subsoil. Steinauer soils have a thin, calcareous surface layer. Dickinson, Malcolm, and Steinauer soils are in positions on the landscape similar to those of the Shelby soil. Judson soils are on foot slopes, and Pawnee soils are in gently sloping areas adjacent to drainageways. Also included are short, steep slopes on the sides of deeply entrenched drainageways. Included areas make up 5 to 15 percent of the unit.

Permeability is moderately slow in the Shelby soil. Available water capacity is high; about 10 inches of water is available in the upper 60 inches. Organic matter content is moderate, or about 2 or 3 percent. The surface layer is slightly acid or medium acid. This soil dries readily after rains and can be worked throughout a fairly wide range of moisture content.

About 65 percent of the acreage of this soil is used for range, pasture, or hay, and about 25 percent is farmed. The rest supports trees.

If used for dryland farming, this soil is poorly suited to cultivated crops. Water erosion is the principal hazard. Because of the slope, the effective use of some farm machinery is limited and terraces and grassed waterways cannot be easily designed and maintained. The best cropping system is one dominated by close-growing crops, such as small grain and legumes. Conservation tillage practices, such as chiseling and disking, that leave all or part of the crop residue on the surface help to control erosion, reduce the evaporation rate, and add organic matter. If clean-cultivated crops are grown, terraces, contour farming, and grassed waterways are needed to control water erosion. Intensive management is necessary in the areas used for crop production; otherwise, the soil should be put to other uses.

If irrigated, this soil is poorly suited to corn, grain sorghum, and soybeans. It is best suited to alfalfa and introduced grasses. Only sprinkler irrigation systems can be used because of the slope. Water erosion is the main hazard. It can be a problem in the wheel tracks if center-pivot irrigation systems are used. Terraces, contour farming, and grassed waterways are needed to control runoff and erosion. A cover of crops or crop residue also helps to control erosion. Adjusting the rate at which water is applied to the water intake rate of the soil helps to prevent excessive runoff and erosion. Timely application and efficient distribution of water are needed.

This soil is suited to introduced or domestic grasses for pasture. Pastures can be alternated with other crops as part of the crop rotation. Cool-season grasses, such as smooth brome or orchardgrass, are suited, either alone or in a mixture with a legume, such as alfalfa. Overgrazing causes low plant vigor and increases the likelihood that small gullies and rills will form during heavy rains. Separate pastures of cool- and warm-season grasses can be used to provide a long season of grazing. Rotation grazing and proper stocking rates help to keep the pasture in good condition. Nitrogen and phosphate fertilizers help to maintain the growth and vigor of the grasses.

This soil is suited to range and native hay. A cover of native grasses is effective in controlling water erosion. The natural plant community is mostly mid and tall grasses, such as big bluestem, indiangrass, little bluestem, porcupinegrass, sideoats grama, and switchgrass. If the plants are overgrazed or improperly harvested for hay, the plant community is mostly Kentucky bluegrass, sideoats grama, tall dropseed, and annual and perennial weeds. If overgrazing continues for many years, sumac, snowberry, and buckbrush invade the plant community. The range condition can be improved or maintained by proper grazing use, timely deferment of grazing, and a grazing system that alternates grazing periods with rest periods and that includes a change in the order of these periods each year. Brush management and prescribed burning help to control the woody plants. Range seeding can improve the stand.

This soil is suited to trees and shrubs grown as windbreaks and as plantings that enhance recreation areas or wildlife habitat. Adapted species survive and grow fairly well. Plant competition, loss of moisture through runoff, and erosion are the principal hazards. Cultivating before planting helps to store moisture in the soil. Cultivating after planting helps to control

competition from weeds. Terracing and planting the seedlings on the contour help to control erosion.

The moderately slow permeability is a limitation if this soil is used as a site for septic tank absorption fields. This limitation can be overcome by increasing the size of the absorption field. Constructing the absorption field on the contour helps to ensure proper performance. The slope is a limitation on sites for sewage lagoons. An alternative site or disposal method should be selected. The shrink-swell potential and the slope are limitations on sites for dwellings and small commercial buildings. Strengthening foundations and backfilling with coarse material help to prevent the structural damage caused by shrinking and swelling. The design of the buildings should accommodate the slope, or the site should be graded.

The surface pavement and base material of local roads and streets should be thick enough to compensate for the low strength of this soil. Providing coarser grained base material helps to ensure better performance.

The capability units are IVe-1, dryland, and IVe-3, irrigated; Silty range site; windbreak suitability group 3.

SkF—Shelby clay loam, 15 to 30 percent slopes. This deep, steep, well drained soil is on commonly dissected, uneven slopes adjacent to the major upland drainageways. It formed in glacial till. Pebbles, stones, and a few boulders are on the surface. Areas are irregular in shape and range from about 5 to 80 acres in size.

Typically, the surface layer is very dark brown, friable clay loam about 9 inches thick. The subsoil is firm clay loam about 27 inches thick. The upper part is very dark grayish brown, the next part is dark brown, and the lower part is mottled grayish brown and brown. The underlying material to a depth of 60 inches or more is light brownish gray and yellowish brown, mottled, calcareous clay loam. In some places, the surface layer is less than 7 inches thick. In other places, the soil is leached of carbonates and the subsoil and underlying material are grayish and have more clay. In some areas, the underlying material has more sand.

Included with this soil in mapping are areas of Pawnee soils, which have a clayey subsoil; Dickinson fine sandy loams; the silty Malcolm soils; and the calcareous Steinauer soils. Also included are escarpments along creek channels; deeply entrenched drainageways that have short, very steep side slopes; and a few areas of narrow bottom lands along the lower parts of the drainageways. Included areas make up 10 to 35 percent of the unit.

Permeability is moderately slow in the Shelby soil. Available water capacity is high. Organic matter content is moderate, or about 2 percent. The surface layer is slightly acid or medium acid.

Nearly all of the acreage supports trees or grasses and is used as range, pasture, forest, or habitat for wildlife. This soil is not suited to cultivation because of the steep, uneven slopes and a severe hazard of water erosion.

This soil is suited to range. A cover of native grasses is effective in controlling water erosion. The natural plant community is mostly mid and tall grasses, such as big bluestem, indiangrass, little bluestem, porcupinegrass, sideoats grama, and switchgrass. If the plants are overgrazed, the plant community is mostly Kentucky bluegrass, sideoats grama, tall dropseed, and annual and perennial weeds. If overgrazing continues for many years, sumac, snowberry, and buckbrush invade the plant community. The range condition can be improved or maintained by proper grazing use, timely deferment of grazing, and a grazing system that alternates grazing periods with rest periods and that includes a change in the order of these periods each year. Brush management and prescribed burning help to control the woody plants.

The productivity of the forested areas can be increased by fencing out livestock, removing the less desirable trees, and other measures that improve timber stands.

This soil is generally not suited to windbreaks. Adapted species of trees and shrubs have a fair chance of survival and growth. The slope, however, generally restricts the use of machinery, and water erosion is a severe hazard. In some areas, slopes are smooth enough for the use of machinery. In these smooth areas, seedlings can be planted on the contour in a shallow furrow 18 to 24 inches wide. In areas where machinery cannot be used, hand planting is needed.

Because of the steep slope, this soil is not suitable as a site for sanitary facilities or for most buildings. Low strength and the steep slope are limitations on sites for local roads and streets. The surface pavement and base material should be thick enough to compensate for the low strength of the soil. Providing coarser grained base material helps to ensure better performance. Building on the contour or cutting and filling help to provide a suitable grade.

The capability unit is VIe-1, dryland; Silty range site; windbreak suitability group 10.

StF—Steinauer clay loam, 15 to 20 percent slopes. This deep, somewhat excessively drained soil is on uneven, convex slopes in the uplands. It formed in glacial till. Slopes average about 17 percent. Cobblestones, pebbles, and a few scattered boulders are on the surface. Areas are about 5 to 30 acres in size.

Typically, the surface layer is very dark grayish brown, friable, calcareous clay loam about 6 inches thick. The transition layer is brown, friable, calcareous clay loam about 11 inches thick. The underlying material to a depth of 60 inches or more is light brownish gray, mottled, calcareous clay loam.

Included with this soil in mapping are small areas of Burchard, Pawnee, and Shelby soils. These soils are deeper to carbonates than the Steinauer soil. Also, they have a thicker surface layer. Pawnee soils have a clay subsoil. They are in gently sloping areas adjacent to drainageways. Burchard and Shelby soils are in positions on the landscape similar to those of the Steinauer soil. Included soils make up 2 to 12 percent of the unit.

Permeability is moderately slow in the Steinauer soil. Available water capacity is high. Organic matter content is moderately low. This soil is mildly alkaline or moderately alkaline, and it has free lime. Workability is good within a medium range of moisture content.

Nearly all areas support grass and are used as range. A few small areas support trees or are cultivated. This soil is generally not suited to cultivated crops because of the slope and a severe hazard of water erosion.

This soil is suited to range. A cover of native grasses is effective in controlling water erosion. The natural plant community is mostly mid and tall grasses, such as big bluestem, indiangrass, little bluestem, porcupinegrass, sideoats grama, and switchgrass. If the plants are overgrazed, the plant community is mostly sideoats grama, blue grama, Kentucky bluegrass, tall dropseed, and annual and perennial weeds. If overgrazing continues for several years, bur oak, eastern redcedar, sumac, snowberry, and buckbrush invade the plant community. The range condition can be maintained or improved by proper grazing use, timely deferment of grazing, and a grazing system that alternates grazing periods with rest periods and that includes a change in the order of these periods each year. Brush management and prescribed burning help to control woody plants. Range seeding can improve the stand.

This soil is suited to the trees and shrubs grown as windbreaks and as plantings that enhance recreation areas or wildlife habitat. Planted trees and shrubs have a fair chance of survival but grow poorly. The best suited species are those that can tolerate the high content of lime. Erosion and the limited amount of available moisture are the principal management concerns. Cultivating before and after planting helps to overcome competition from weeds. Planting the seedlings on the contour and in strips with intervening areas of sod helps to control erosion. Conifers can be planted in a wide, shallow furrow where the ground cover consists of native grasses. Windbreaks should be protected from the damage caused by livestock.

Because of the slope, this soil generally is not suitable for sanitary facilities. The slope also is a limitation on sites for dwellings and small commercial buildings. The design of the buildings should accommodate the slope, or the site should be graded.

Cutting and filling are generally needed to establish a suitable grade for local roads and streets. The surface pavement and base material should be thick enough to compensate for the low strength of this soil. Providing coarser grained base material helps to ensure better performance.

The capability unit is VIe-9, dryland; Limy Upland range site; windbreak suitability group 8.

Wc—Wabash silty clay, 0 to 1 percent slopes. This deep, nearly level, very poorly drained soil is on bottom lands. It is occasionally flooded. It formed in clayey alluvium. Areas are circular or oblong and range from 10 to 80 acres in size.

Typically, the surface layer is very dark gray, firm silty clay about 8 inches thick. The subsurface layer is black, very firm silty clay about 12 inches thick. The subsoil to a depth of more than 60 inches is black, very firm silty clay. In some places, the subsoil is calcareous. In other places, the subsurface layer is silty clay loam.

Included with this soil in mapping are small areas of Zoe soils. These soils have alkaline salts. They are in landscape positions similar to those of the Wabash soil. They make up 0 to 5 percent of the unit.

Permeability is very slow in the Wabash soil. Available water capacity is moderate; about 8 inches of water is available in the upper 60 inches. Organic matter content is moderate, or about 4 percent. The surface layer is neutral or slightly acid. A seasonal high water table is within a depth of 1 foot. This soil dries slowly. It is difficult to work because it is sticky when wet and cracks and becomes very hard when dry. It can be worked only within a narrow range of moisture content.

Most of the acreage of this soil is cultivated. A few areas are used for pasture or range.

If used for dryland farming, this soil is suited to soybeans, corn, and grain sorghum. Wetness is the principal limitation. Grain sorghum or soybeans are better suited than corn because they can be planted later in the spring. Also, hot, dry periods in the summer can adversely affect corn. The soil does not release moisture quickly enough to maintain the corn plants. Surface drainage can be improved by arranging the rows of crops in a direction that conforms to the lay of the land or by land grading and leveling. Filling in low areas so that there is an even land grade throughout the field helps to drain the surface. In places, surface ditching may be feasible. The excessive compaction caused by tillage when the soil is wet should be avoided because it further restricts permeability. Returning crop residue to the soil improves the organic matter content and soil structure.

If irrigated, this soil is suited to corn, grain sorghum, and soybeans. Gravity or sprinkler systems can be used. Wetness often delays tillage and cultivation in the spring. Adjustments in the planting dates and the crop varieties are necessary in most years. Land leveling improves surface drainage. It establishes a suitable grade for a uniform distribution of water in areas irrigated by a gravity system. Tile drains or open ditches can lower the water table where suitable outlets are available. Flooding

can be controlled by diversion terraces on the local flood plain. Carefully controlling the rate and time of water application helps to achieve efficient water management on this very slowly permeable soil.

This soil is suited to introduced or domestic grasses for pasture. Pastures can be alternated with other crops as part of the crop rotation. Reed canarygrass and creeping foxtail are suitable. Excessive wetness limits the choice of grasses and legumes and makes seeding difficult. Overgrazing or grazing during wet periods compacts the soil, and grazing when the water table is highest damages the plants. Wetness can be reduced by land leveling and by tile drains or open ditches where suitable outlets are available. Rotation grazing and proper stocking rates help to keep the pasture in good condition. Nitrogen fertilizers help to maintain the growth and vigor of the grasses.

This soil is suited to range and native hay. The natural plant community is mostly mid and tall grasses, such as big bluestem, indiangrass, little bluestem, and switchgrass. If the plants are overgrazed or improperly harvested for hay, the plant community is mostly tall dropseed, Kentucky bluegrass, western wheatgrass, and many annual and perennial weeds. Snowberry and buckbrush invade the plant community. The range condition can be improved or maintained by proper grazing use, timely deferment of grazing, and a grazing system that alternates grazing periods with rest periods and that includes a change in the order of these periods each year. Brush management helps to control woody plants. Range seeding can improve the stand.

This soil is suited to the trees and shrubs that are tolerant of wetness. Survival is good. Establishing seedlings is difficult during wet years. Weeds can be controlled by cultivating with conventional equipment before and after planting and by applying selected herbicides. In some years, cultivating and planting are postponed because the soil is too wet.

Because of the flooding, the wetness, and the very slow permeability, this soil is not suited to septic tank absorption fields. It is suited to sewage lagoons if the site is diked or otherwise protected from flooding. The soil is not suitable as a site for buildings because of the flooding, the wetness, and the shrink-swell potential.

Constructing local roads on suitable, well compacted fill material and establishing adequate side ditches and culverts help to prevent the damage caused by flooding and wetness. The surface pavement and base material should be thick enough to compensate for the low strength of this soil. Providing coarser grained base material helps to ensure better performance.

The capability units are IIIw-1, dryland, and IIIw-1, irrigated; Clayey Overflow range site; windbreak suitability group 2W.

Wt—Wymore silty clay loam, 0 to 2 percent slopes. This deep, nearly level, moderately well drained soil is mainly on the upland divides. In a few areas, it is on foot slopes or stream terraces. It formed in loess. Areas are circular or oblong and range from 10 to more than 200 acres in size.

Typically, the surface layer is black, friable silty clay loam about 10 inches thick. The subsoil is about 40 inches thick. It is very dark grayish brown, firm silty clay in the upper part; dark grayish brown, mottled, firm silty clay in the next part; and grayish brown, mottled, firm silty clay loam in the lower part. The underlying material to a depth of more than 70 inches is light grayish brown, mottled silty clay loam. In some places, the surface layer is silt loam. In other places, the subsoil is very dark gray at a depth of 24 inches or more. In a few small areas, the upper part of the subsoil is dark brown silty clay loam. In places, the depth to the underlying material is more than 50 inches.

Included with this soil in mapping are areas of soils in small circular depressions where water collects for short periods. These soils are poorly drained. They make up 0 to 5 percent of the unit.

Permeability is slow in the Wymore soil. Available water capacity is high; about 10 inches of water is available in the upper 60 inches. Organic matter content is moderate, or about 4 percent. The surface layer is medium acid or slightly acid. This soil dries slowly in spring and during prolonged periods of rain. A perched seasonal high water table is at a depth of 1 to 3 feet in spring. Workability is good during periods of optimum moisture content. The soil releases moisture slowly to plants.

Nearly all of the acreage is cultivated. If used for dryland farming, this soil is suited to grain sorghum, corn, wheat, soybeans, oats, alfalfa, clover, and grasses. Hot, dry periods in summer can adversely affect cultivated crops. Otherwise, the soil can be cultivated intensively without risk of damage if it is properly managed. Maintaining the proper plant population, based on the amount of soil moisture, is an effective management practice. Returning plant residue to the soil increases the rate of water intake and helps to maintain the organic matter content. Delaying tillage during periods in spring when the soil is too wet minimizes compaction and preserves soil structure. Legumes in the cropping system help to maintain the fertility and porosity of this soil.

If irrigated, this soil is suited to corn, grain sorghum, and soybeans. If well managed, it can be intensively cultivated. Conservation tillage practices, such as chiseling or disking, that leave all or part of the crop residue on the surface conserve moisture and help to maintain the organic matter content.

Gravity or sprinkler irrigation systems can be used on this soil. Less land preparation is needed if a sprinkler system is used. A proper grade is needed in areas irrigated by a gravity system. This commonly can be achieved by land leveling. Carefully controlling the rate

and time of water application helps to achieve efficient water management.

This soil is suited to the trees and shrubs grown as windbreaks and as plantings that enhance recreation areas or wildlife habitat. Seedlings of adapted species have a good chance of survival and growth. Drought and plant competition are the principal hazards. Weeds and grasses can be controlled by cultivating between the tree rows with conventional equipment and by rototilling and applying herbicides in the rows. Supplemental watering is needed during dry periods.

The slowly permeable subsoil and the seasonal wetness severely limit this soil as a site for septic tank absorption fields. An alternative system should be considered. The soil is suited to sewage lagoons. Strengthening the foundations of buildings and backfilling with coarse material help to prevent the structural damage caused by the shrinking and swelling. On sites for dwellings with basements, a tile drainage system at the floor level carries away seepage water when the soil is saturated.

The surface pavement and base material of local roads and streets should be thick enough to compensate for the low strength of this soil. Providing coarser grained base material helps to ensure better performance. A surface drainage system helps to prevent the damage caused by frost action. Crowning the road by grading and establishing adequate side ditches help to drain the surface.

The capability units are IIs-2, dryland, and IIs-1, irrigated; Clayey range site; windbreak suitability group 4L.

WtC—Wymore silty clay loam, 2 to 7 percent slopes. This deep, gently sloping, moderately well drained soil is mainly on ridges in the uplands. In a few areas, it is on foot slopes or stream terraces. It formed in loess. Slopes are mostly plane or slightly convex and average about 4 percent. Areas range from about 5 to 40 acres in size.

Typically, the surface layer is black, friable silty clay loam about 8 inches thick. The subsurface layer is very dark gray, friable silty clay loam about 4 inches thick. The subsoil is about 38 inches thick. The upper part is very dark gray, firm silty clay; the next part is dark grayish brown and grayish brown, mottled, firm silty clay; and the lower part is grayish brown, mottled, firm silty clay loam. The underlying material to a depth of more than 60 inches is light brownish gray, mottled silty clay loam. In a few places, the subsoil is very dark grayish brown at a depth of 24 inches or more. In some areas the subsoil is clay below a depth of 24 inches and is underlain by glacial material.

Included with this soil in mapping are small areas of the well drained Judson soils on foot slopes and small areas of the stratified, silty Nodaway soils on bottom lands. Included soils make up 2 to 10 percent of the unit.

Permeability is slow in the Wymore soil. Available water capacity is high; about 10 inches of water is available in the upper 60 inches. Organic matter content is moderate, or about 4 percent. The surface layer is medium acid or slightly acid. This soil dries slowly in spring. A perched seasonal high water table is at a depth of 1 to 3 feet in spring. Workability is good during periods of optimum moisture content. The soil releases moisture slowly to plants.

Some of the acreage of this soil is cultivated. Some areas support grass and are used as pasture or range.

If used for dryland farming, this soil is suited to grain sorghum, wheat, corn, soybeans, oats, alfalfa, and clover. Water erosion and the loss of moisture and soil nutrients through runoff are the principal management concerns. Hot, dry periods in summer can adversely affect cultivated crops. Applying a system of conservation tillage and returning crop residue to the soil increase the rate of water intake, reduce the evaporation rate, and help to maintain the content of organic matter. Terraces, grassed waterways, and contour farming help to control water erosion (fig. 6). Row crops can be grown more frequently if these measures are applied. The excessive compaction caused by tillage should be avoided, particularly when the soil is wet, because it further restricts permeability.

If irrigated, this soil is suited to corn, grain sorghum, and soybeans. Only sprinkler irrigation systems are suited because of the slope. Water erosion is the main hazard. It can be a problem in the wheel tracks if center-pivot irrigation systems are used. Terraces, contour farming, and grassed waterways are needed to control runoff and erosion. A cover of crops or crop residue also helps to control erosion. Adjusting the rate at which water is applied to the water intake rate of the soil helps to prevent excessive runoff and erosion. Timely application and efficient distribution of water are needed.

This soil is suited to introduced or domestic grasses for pasture. Pastures can be alternated with other crops as part of the crop rotation. Cool-season grasses, such as smooth brome and orchardgrass, are suited, either alone or in a mixture with a legume, such as alfalfa. Overgrazing or grazing during wet periods compacts the soil. Overgrazing also causes low plant vigor and increases the likelihood that small gullies and rills will form during heavy rains. Separate pastures of cool- and warm-season grasses can be used to provide a long season of grazing. Rotation grazing and proper stocking rates help to keep the pasture in good condition. Nitrogen fertilizers help to maintain the growth and vigor of the grasses.

This soil is suited to range and native hay. A cover of native grasses is effective in controlling water erosion. The natural plant community is mostly mid and tall grasses, such as big bluestem, indiangrass, little bluestem, porcupinegrass, and switchgrass. If the plants are overgrazed or improperly harvested for hay, the plant

Figure 6.—Terraces, grassed waterways, and contour farming in an area of Wymore silty clay loam, 2 to 7 percent slopes.

community is mostly Kentucky bluegrass, sideoats grama, tall dropseed, and annual and perennial weeds. If overgrazing continues for many years, sumac, snowberry, and buckbrush invade the plant community. The range condition can be improved or maintained by proper grazing use, timely deferment of grazing, and a grazing system that alternates growing periods with rest periods and that includes a change in the order of these periods each year. Brush management and prescribed burning help to control the woody plants. Range seeding can improve the stand.

This soil is suited to the trees and shrubs grown as windbreaks and as plantings that enhance recreation areas or wildlife habitat. Adapted species have a good chance of survival and growth. Plant competition and erosion are the principal hazards. Cultivating before planting helps to store moisture in the soil. Cultivating after planting helps to control competition from weeds. Rototillers or appropriate herbicides can be used in the rows. Planting on the contour helps to control erosion. Windbreaks should be protected from the damage caused by livestock.

The slowly permeable subsoil and the seasonal wetness severely limit this soil as a site for septic tank absorption fields. An alternative system or site should be considered. The soil is suitable for sewage lagoons, but grading is required to modify the slope and shape the lagoon. Strengthening the foundations of buildings and backfilling with coarse material help to prevent the structural damage caused by shrinking and swelling. On sites for dwellings with basements, a tile drainage system at the floor level helps to carry away seepage water when the soil is saturated. A suitable outlet is needed.

The surface pavement and base material of local roads and streets should be thick enough to compensate for the low strength of this soil. Providing coarser grained base material helps to ensure better performance. A

good surface drainage system helps to prevent the damage caused by frost action. Crowning the road and establishing adequate side ditches help to drain the surface.

The capability units are IIIe-2, dryland, and IIIe-1, irrigated; Clayey range site; windbreak suitability group 4L.

WyC2—Wymore silty clay, 2 to 7 percent slopes, eroded. This deep, gently sloping, moderately well drained soil is on high ridges in the uplands. It formed in loess. It commonly is dissected by drainageways. In places the ridges are separated by lower lying, saddlelike areas. The ridges between the drainageways are convex, and the saddles and low-lying areas adjacent to the drainageways are plane or concave. Slopes average about 4 percent. Areas are mostly long or broad, continuous strips several hundred acres in size.

Nearly all of the very dark original surface soil of this eroded soil has been removed (fig. 7). The surface layer is mostly subsoil material. Typically, it is very dark grayish brown, firm silty clay about 8 inches thick. The subsoil is silty clay about 24 inches thick. It is dark grayish brown and very firm in the upper part and grayish brown, mottled, and firm in the lower part. The underlying material to a depth of more than 60 inches is light brownish gray, mottled silty clay loam. In small, less eroded areas, the surface layer is silty clay loam more than 10 inches thick. In other areas, part of the clayey subsoil has been eroded. In some places, the subsoil is silty clay loam. In other places, the lower part of the subsoil and the underlying material consist of glacial material.

Included with this soil in mapping are wet, gumbo, or scabby spots. These spots are in areas where this soil is adjacent to the clayey Pawnee or Mayberry soils. Also included are small areas of the well drained Judson soils on foot slopes and the stratified, silty Nodaway soils on bottom lands. Included areas make up 2 to 10 percent of the unit.

Permeability is slow in the Wymore soil. Available water capacity is high; about 10 inches of water is available in the upper 60 inches. Organic matter content is moderate, or about 2 percent. The surface layer is

Figure 7.—Sheet erosion in an area of Wymore silty clay, 2 to 7 percent slopes, eroded.

slightly acid. The soil dries slowly in spring. A perched seasonal high water table is at a depth of 1 to 3 feet in the spring. Workability is fair only during periods of optimum moisture content. The soil is sticky when wet, firm when moist, and very hard when dry. It has large cracks when dry. It releases moisture slowly to plants.

Most of the acreage is cultivated. Small areas are used for pasture or reseeded range.

If used for dryland farming, this soil is suited to grain sorghum, wheat, corn, soybeans, oats, alfalfa, and clover. Water erosion and the loss of moisture and of soil nutrients through runoff are the principal management concerns. Hot, dry periods in the summer can adversely affect cultivated crops. Cracks form in this soil as it dries. They increase the evaporation rate. Applying a system of conservation tillage and returning crop residue to the soil increase the rate of water intake, reduce the evaporation rate, and help to maintain the content of organic matter. Terraces, grassed waterways, and contour farming help to control water erosion. Row crops can be grown more frequently if these measures are applied. Limited use of clean-cultivated row crops and maximum use of close-growing small grain, legumes, or legume-grass mixtures are effective in controlling water erosion. The excessive compaction caused by tillage should be avoided, particularly when the soil is wet, because it further restricts permeability. Applying fertilizer and including legumes in the cropping sequence help to maintain fertility. Legumes also help to maintain soil porosity.

If irrigated, this soil is poorly suited to corn, grain sorghum, and soybeans. Only sprinkler irrigation systems can be used because of the slope. Water erosion is the main hazard. It can be a problem in the wheel tracks if center-pivot irrigation systems are used. Terraces, contour farming, and grassed waterways are needed to control runoff and erosion. A cover of crops or crop residue also helps to control erosion. Adjusting the rate at which water is applied to the water intake rate of the soil helps to prevent excessive runoff and erosion. Carefully controlling the rate and time of water application helps to achieve efficient water management.

This soil is suited to introduced or domestic grasses for pasture. Pastures can be alternated with other crops as part of the crop rotation. Cool-season grasses, such as smooth brome or orchardgrass, are suited, either alone or in a mixture with a legume, such as alfalfa. Overgrazing or grazing during wet periods compacts the soil. Overgrazing also causes low plant vigor and increases the likelihood that small gullies and rills will form during heavy rains. Separate pastures of cool- and warm-season grasses can be used to provide a long season of grazing. Rotation grazing and proper stocking rates help to keep the pasture in good condition. Nitrogen and phosphate fertilizers help to maintain the growth and vigor of the grasses.

This soil is suited to range and native hay. A cover of native grasses is effective in controlling water erosion. The natural plant community is mostly mid and tall grasses, such as big bluestem, indiangrass, little bluestem, porcupinegrass, and switchgrass. If the plants are overgrazed or improperly harvested for hay, the plant community is mostly Kentucky bluegrass, sideoats grama, tall dropseed, and annual and perennial weeds. If overgrazing continues for many years, sumac, snowberry, and buckbrush invade the plant community. The range condition can be improved or maintained by proper grazing use, timely deferment of grazing, and a grazing system that alternates grazing periods with rest periods and that includes a change in the order of these periods each year. Brush management and prescribed burning help to control the woody plants. Range seeding can improve the stand.

This soil is suited to the trees and shrubs grown as windbreaks and as plantings that enhance recreation areas or wildlife habitat. Adapted species have a good chance of survival and growth. Plant competition and erosion are the principal hazards. Cultivating before planting helps to store moisture in the soil. Cultivating after planting helps to control competition from weeds. Rototillers or appropriate herbicides can be used in the rows. Planting on the contour helps to control water erosion. Supplemental watering is needed during dry periods.

The slowly permeable subsoil and the seasonal wetness severely limit this soil as a site for septic tank absorption fields. An alternative system or site should be considered. The soil is suitable for sewage lagoons, but grading is required to modify the slope and to shape the lagoon. Strengthening the foundations of buildings and backfilling with coarse material help to prevent the structural damage caused by shrinking and swelling. On sites for dwellings with basements, a tile drainage system at the floor level helps to carry away seepage water when the soil is saturated. A suitable outlet is needed.

The surface pavement and base material of local roads and streets should be thick enough to compensate for the low strength of this soil. Providing coarser grained base material helps to ensure better performance. A surface drainage system helps to prevent the damage caused by frost action. Crowning the road by grading and establishing adequate side ditches help to drain the surface.

The capability units are IIIe-2, dryland, and IVe-1, irrigated; Clayey range site; windbreak suitability group 4L.

Zh—Zoe-Zook silty clay loams, 0 to 1 percent slopes. These deep, nearly level, poorly drained soils are on bottom lands. They formed in clayey alluvium and are occasionally flooded. About a third of the areas of the saline-alkali Zoe soil are slightly affected by alkali

salts, a third are moderately affected, and a third are severely affected. Areas range from 5 to 100 acres in size. They are about 45 to 60 percent Zoe soil and 25 to 40 percent Zook soil. The two soils occur as areas so intricately mixed that mapping them separately is not practical.

Typically, the Zoe soil has a surface layer of very dark gray, friable silty clay loam about 12 inches thick. The subsurface layer is about 20 inches thick. It is black, friable silty clay loam in the upper part and very dark gray, firm silty clay in the lower part. It has light colored threads of salt accumulations. The transition layer is very dark gray, very firm, calcareous silty clay about 10 inches thick. The underlying material to a depth of more than 60 inches is dark gray, calcareous silty clay. In places, the subsurface layer is thin and the depth to the underlying material is about 20 inches.

Typically, the Zook soil has a surface layer of very dark gray, friable silty clay loam about 7 inches thick. The subsurface layer also is very dark gray, friable silty clay loam. It is about 12 inches thick. The subsoil is firm silty clay about 25 inches thick. The upper part is very dark gray, and the lower part is dark grayish brown. The underlying material to a depth of 60 inches or more is grayish brown silty clay. In some places, the subsoil is is dark grayish brown at a depth of about 30 inches. In other places, the soil is calcareous below a depth of 40 inches.

Included with these soils in mapping are small areas of Nishna and Wabash soils. These included soils do not have the alkali salts characteristic of the Zoe soil and have more clay in the surface layer than the Zook soil. They are in positions on the landscape similar to those of the Zoe and Zook soils. They make up 5 to 15 percent of the unit.

Permeability is slow in the Zoe and Zook soils. Available water capacity is moderate in the Zoe soil and high in the Zook soil. About 8 inches of water is available in the upper 60 inches of the Zoe soil, and 9 inches is available in the upper 60 inches of the Zook soil. Organic matter content is moderate, or about 3 percent, in the Zoe soil and high, or about 5 percent, in the Zook soil. Reaction is neutral in the surface layer of the Zoe soil and medium acid or slightly acid in the surface layer of the Zook soil. The soil-moisture-plant relationship in the Zoe soil is poor because of the content of sodium salts. Both soils are difficult to work because they stay wet during rainy periods and become very hard and droughty during dry periods. The depth to a water table is 1 to 3 feet during seasonal high rainfall.

Most of the acreage of these soils is cultivated. A few small areas are used for pasture or range.

If used for dryland farming, these soils are poorly suited to cultivated crops. Because of the restrictive physical properties, the Zoe soil is best suited to cool-season small grain, such as oats and barley, and drought-resistant crops, such as grain sorghum. Soybeans also can be planted after a wet spring. Surface drainage can be improved by arranging the rows of crops in a direction that conforms to the lay of the land, by filling in low areas, and by establishing an even grade throughout the field. In places, surface ditching may be feasible. The excessive compaction caused by tillage should be avoided, particularly when the soil is wet, because it further restricts permeability. Adding any kind of organic material, such as crop residue, hay, barnyard manure, and corncobs, increases the rate of water infiltration, helps to hold water in the soil, reduces the evaporation rate, and improves the ease of tillage.

If irrigated, these soils are poorly suited to corn, grain sorghum, and soybeans. Gravity or sprinkler systems can be used. The wetness often delays tillage and cultivation. Adjustments in the planting dates and the crop varieties are necessary in most years. Land leveling improves surface drainage. It establishes a suitable grade for a uniform distribution of water in areas irrigated by a gravity system. Leveled areas that have been cut are commonly deficient in organic matter, phosphorus, and zinc. Tile drains or open ditches can lower the water table where suitable outlets are available. Flooding can be controlled by diversion terraces on the local flood plain. Carefully controlling the rate and time of water application helps to achieve efficient water management on these slowly permeable soils.

These soils are poorly suited to introduced or domestic grasses for pasture. Pastures can be alternated with other crops as part of the crop rotation. Tall wheatgrass, reed canarygrass, and creeping foxtail are suitable species. Overgrazing or grazing during wet periods compacts the soils, and grazing when the water table is highest damages the plants. Wetness can be reduced by land leveling and by tile drains or open ditches where suitable outlets are available. Rotation grazing and proper stocking rates help to keep the pasture in good condition. Nitrogen fertilizers help to maintain the growth and vigor of the grasses.

These soils are suited to range and native hay. On the Zoe soil, the natural plant community is mostly inland saltgrass, plains bluegrass, slender wheatgrass, switchgrass, western wheatgrass, and grasslike plants, such as various sedges. On the Zook soil, the natural plant community is mostly mid and tall grasses, including big bluestem, indiangrass, little bluestem, and switchgrass. If the plants are overgrazed or improperly harvested for hay, the plant community is mostly Kentucky bluegrass, foxtail barley, inland saltgrass, western wheatgrass, sedges, and annual and perennial weeds. In places, snowberry and buckbrush invade the plant community. Overgrazing when the soils are wet results in compaction and the formation of small mounds and damages the plants. The range condition can be improved or maintained by proper grazing use, timely deferment of grazing, and a grazing system that alternates grazing periods with rest periods and that

includes a change in the order of these periods each year.

Because of the sodium salts and poor physical properties, the Zoe soil is generally not suited to windbreaks and is poorly suited to the trees and shrubs planted to enhance recreation areas or wildlife habitat. The Zook soil, however, is suited to trees and shrubs. Establishing seedlings is difficult in wet years. Only the species tolerant of saline or alkali conditions should be planted on the Zoe soil. During wet years, planting may be delayed or postponed until the soil has begun to dry. Undesirable weeds and grasses can be controlled by cultivating with conventional equipment between the tree rows and hoeing by hand or rototilling in the rows and close to the trees. Supplemental water is needed on the Zoe soil during dry periods.

Because of the flooding, the wetness, and the slow permeability, these soils are not suited to septic tank absorption fields. They are suited to sewage lagoons only if the lagoon is raised on fill material or diked, so that it is protected from flooding. The soils are not suitable as sites for buildings because of the flooding, the wetness, and a high shrink-swell potential.

Constructing local roads on suitable, well compacted fill material above flood levels, establishing adequate side ditches, and installing culverts help to prevent the damage caused by flooding and the seasonal high water table. The surface pavement and base material should be thick enough to compensate for the low strength of the soils. Providing coarser grained base material helps to ensure better performance. Installing a surface drainage system and a gravel moisture barrier in the subgrade helps to prevent the damage caused by frost action. Crowning the road and establishing adequate side ditches help to drain the surface. Mixing the base material with additives, such as hydrated lime, helps to prevent excessive shrinking and swelling.

The capability units are IVs-1, dryland, and IVs-1, irrigated. The Zoe soil is in Saline Subirrigated range site and windbreak suitability group 9S. The Zook soil is in Clayey Overflow range site and windbreak suitability group 2W.

Zo—Zook silty clay loam, 0 to 1 percent slopes. This deep, nearly level, poorly drained soil is on bottom lands. It is occasionally flooded. It formed in silty and clayey alluvium. Areas range from about 20 acres to several hundred acres in size.

Typically, the surface layer is black, friable silty clay loam about 8 inches thick. The subsurface layer is very dark gray, friable silty clay loam about 14 inches thick. The subsoil to a depth of 60 inches or more is very dark gray, mottled, firm silty clay. In places, the surface layer is silt loam, loam, or clay loam.

Included with this soil in mapping are small areas of Kennebec, Nodaway, Wabash, and Zoe soils. The moderately well drained Kennebec and Nodaway soils are silty throughout. They are slightly higher on the landscape than the Zook soil. Wabash soils have more clay in the upper part than the Zook soil. Zoe soils have alkaline salts. Wabash and Zoe soils are in the same general position on the landscape as the Zook soil. Included soils make up 2 to 10 percent of the unit.

Permeability is slow in the Zook soil. Available water capacity is high; about 9 inches of water is available in the upper 60 inches. Organic matter content is high, or about 5 percent. The surface layer is slightly acid. This soil dries slowly and stays wet in winter and early in spring and during periods of continuous rainfall. A seasonal high water table is at a depth of 1 to 3 feet.

Nearly all of the acreage of this soil is cultivated. A few small areas are used for pasture or range.

If used for dryland farming, this soil is suited to corn, soybeans, and grain sorghum. Row crops can be grown several years in succession, but weeds, plant diseases, and insects should be controlled. Wetness is the principal limitation, especially during long periods of rainfall. Surface drainage can be improved by arranging the rows of crops in a direction that conforms to the lay of the land or by land grading and leveling. Filling in low areas so that there is an even land grade throughout the field helps to drain the surface. The excessive compaction caused by tillage should be avoided, particularly when the soil is wet, because it further restricts permeability. Returning crop residue to the soil helps to maintain the content of organic matter and soil structure.

If irrigated, this soil is suited to corn, grain sorghum, and soybeans. Gravity or sprinkler systems can be used. The wetness often delays tillage and cultivation. Adjustments in the planting dates and the crop varieties are necessary in most years. Land leveling improves surface drainage. It also establishes a suitable grade for a uniform distribution of water in areas irrigated by a gravity system. Tile drains or open ditches can lower the water table where suitable outlets are available. Flooding can be controlled by diversion terraces on the local flood plain. Carefully controlling the rate and time of water application helps to achieve efficient water management on this slowly permeable soil.

This soil is suited to introduced or domestic grasses for pasture. Pastures can be alternated with other crops as part of the crop rotation. Cool-season grasses, such as smooth brome, reed canarygrass, and creeping foxtail, are suited. Overgrazing or grazing during wet periods compacts the soil. Overgrazing also causes low plant vigor. Separate pastures of cool- and warm-season grasses can be used to provide a long season of grazing. Rotation grazing and proper stocking rates help to keep the pasture in good condition. Nitrogen fertilizers help to maintain the growth and vigor of the grasses.

This soil is suited to range and native hay. The natural plant community is mostly mid and tall grasses, including big bluestem, indiangrass, little bluestem, and

switchgrass. If the plants are overgrazed or improperly harvested for hay, the plant community is mostly tall dropseed, Kentucky bluegrass, western wheatgrass, and many annual and perennial weeds. Snowberry and buckbrush invade the plant community. The range condition can be improved or maintained by proper grazing use, timely deferment of grazing, and a grazing system that alternates grazing periods with rest periods and that includes a change in the order of these periods each year. Brush management and prescribed burning help to control the woody plants. Range seeding can improve the stand.

This soil is suited to the trees and shrubs that are tolerant of occasional wetness. The survival rate is good. Establishing seedlings is difficult during wet years. Weeds can be controlled by cultivation with conventional equipment before and after planting and by applications of selected herbicides. During wet years cultivation may be delayed until the soil has begun to dry.

Because of the flooding, the wetness, and the slow permeability, this soil is not suited to septic tank absorption fields. It is suited to sewage lagoons only if the lagoon is raised on fill material or diked, so that it is protected from flooding. The soil is not suitable as a site for buildings because of the flooding, the wetness, and a high shrink-swell potential.

Constructing local roads on suitable, well compacted fill material above flood levels helps to prevent the damage caused by flooding. The surface pavement and base material should be thick enough to compensate for the low strength of the soil. Providing coarser grained base material helps to ensure better performance. Installing a surface drainage system and a gravel moisture barrier in the subgrade helps to prevent the damage caused by frost action. Crowning the road and establishing adequate side ditches help to drain the surface.

The capability units are IIw-4, dryland, and IIw-1, irrigated; Clayey Overflow range site; windbreak suitability group 2W.

Use and Management of the Soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavior characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as rangeland; for windbreaks; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

The soils in the survey area are assigned to various interpretive groups at the end of each map unit description and in some of the tables. The groups for each map unit also are shown in the section "Interpretive Groups," which follows the tables at the back of this survey.

Crops and Pasture

William E Reinsch, conservation agronomist, and Howard Sautter soil scientist, Soil Conservation Service, prepared this section

General management needed for crops and pasture is suggested in this section. The crops or pasture plants best suited to the soils are identified, the system of land capability classification used by the Soil Conservation Service is explained, and the estimated yields of the main crops and hay and pasture plants are listed for each soil.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Detailed Soil Map Units." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

Most of the agricultural land in Johnson County is used for crops. About 146,000 acres is planted to crops, according to the Nebraska Conservation Needs Inventory. The largest acreage is used for grain sorghum, followed by corn, wheat, soybeans, and alfalfa. About 10,000 acres is irrigated cropland. About 42,000 acres is used for pasture.

Cropland Management

Most of the soils in Johnson County are suitable for crop production. On a large acreage on uplands, however, erosion is a severe hazard and conservation practices are needed to protect the soils. A drainage system is needed in poorly drained soils, which generally are on bottom lands.

Good management practices on cropland help to control runoff and erosion, conserve moisture, help to maintain soil tilth, and improve drainage. Terraces, contour farming, grassed waterways, and a conservation tillage system that leaves crop residue on the surface help to control water erosion.

Most kinds of tillage reduce the amount of residue left on the surface, break down the natural soil structure, and create a plowpan, which restricts permeability. Therefore, the soils should be tilled only when tillage is essential. Leaving crop residue on the surface or growing a protective plant cover minimizes sealing and crusting of the surface during and after heavy rains. In winter, standing stubble catches drifting snow, which provides additional moisture. As an additional benefit,

running farm machinery requires less energy and labor if tillage is kept to a minimum.

The overall hazard of erosion can be reduced if the less erodible and more productive soils are used for row crops and the more erodible soils are used for close-growing crops, such as small grain and alfalfa, or for hay and pasture.

A resource management system consists of the sequence of crops grown in a field and the management needed on the soil. It should preserve tilth and fertility, maintain a plant cover that protects the soil from erosion, and control weeds, insects, and diseases. Resource management systems on cropland vary with the soils. For example, on Pawnee clay, 3 to 9 percent slopes, eroded, a high percentage of grasses and legumes is required in the cropping sequence to maintain tilth and the organic matter content. Also, terraces, grassed waterways, contour farming, and conservation tillage are needed to control erosion. On Kennebec silt loam, 0 to 1 percent slopes, a high percentage of row crops can be grown in the cropping sequence. Terraces and contour farming are not needed on this soil.

Working the soils helps to prepare a seedbed, controls weeds, and provides a favorable growing medium for plants. Conservation tillage systems, such as no-till, till-plant, disk, or chisel and plant, are well suited to row crops. Corn or sorghum planted into soybean residue without tillage is an example of a typical no-till conservation tillage system for row crops. Grasses can be established by drilling into stubble without further seedbed preparation.

Fertilizer

Testing the soils used for cultivated crops helps to determine the need for additional nutrients. The kind and amount of nutrients to be applied should be based on the results of these tests. The kind of crop to be grown, the availability of moisture, and the previous cropping history are considered when the need for fertilizer is determined. Some crops, such as corn, are heavy users of nitrogen, and other crops, such as wheat and alfalfa, are heavy users of phosphorus.

For nonlegume crops, nitrogen fertilizer is beneficial on all soils in the county, especially on eroded soils. Nitrogen stimulates plant growth. Somewhat smaller quantities are needed when the subsoil is dry. Generally, less nitrogen is needed for a grain or forage crop that immediately follows a legume in the cropping sequence because nitrogen is fixed in the soil by legumes and thus is available to the succeeding crop.

Phosphate fertilizer is not leached through the soil profile and must be incorporated into the soil. It is beneficial on all upland soils, particularly the eroded soils. The content of phosphorus generally is higher on soils on bottom lands than on upland soils, but all soils should be checked for phosphorus deficiencies. Legumes especially benefit from applications of phosphate fertilizer.

Lime is an important component of the soil. It facilitates plant growth and affects soil reaction. Soil reaction determines, to a great extent, the availability of elements, such as phosphorus, nitrogen, and minor nutrients. Some soils in the county, such as Nishna and Steinauer soils, are calcareous and contain free lime. Carbonates in these soils sometimes hinder the availability of phosphorus and minor elements. On all the other soils in the county, the degree of acidity generally is slight to strong and applications of lime would be beneficial. Soils should be tested to determine the amount of lime needed. Liming an acid soil helps to make other elements available for plant growth.

Zinc is the minor element most likely to be deficient in eroded soils and in soils that have been scalped after the construction of terraces. The content of potassium generally is very high in all the soils in the county.

Herbicides

Herbicides are very effective in controlling weeds. Care should be taken to apply the correct type of herbicide at the proper rate, depending on soil conditions. The colloidal clay and humus fraction of the soil is responsible for the greatest chemical activity in the soil. Herbicides can damage crops on fine sandy loams, which are low in content of colloidal clay, and on soils in which the organic matter content is moderately low or low. Consequently, application rates should be correspondingly lowered on these soils.

Irrigation

About 10,000 acres in Johnson County was irrigated in 1982. Irrigation is used mainly to supplement natural rainfall during critical stages of plant growth. These critical stages occur in July or early in August, during pollination of corn or sorghum and during early seed development of plants. In an average year, an additional 4 to 8 inches of water is applied to the fields by gravity or sprinkler irrigation systems. Most of the water comes from deep wells.

On soils that have slopes of 2 to 7 percent, such as the more sloping Wymore soils, and on soils that have slopes of 3 to 9 percent, such as the less sloping Pawnee soils, sprinkler irrigation is the most practical system. Conservation practices that help to control erosion on nonirrigated cropland also can be applied to irrigated cropland. These include terraces, contour farming, grassed waterways, and a system of conservation tillage that leaves a protective cover of crop residue on the soil. Measures that maintain the terraces and grassed waterways are needed. The hazard of erosion is reduced if conservation practices are used. During dry periods in July and August, as small cracks form in the soil, the soil is receptive to water, and crop

plants in their peak growth form a vegetative canopy over the soil. The canopy protects the soil from the forceful impact of waterdrops, either from sprinkler systems or from heavy rains. Sprinkler irrigation is least efficient on hot, windy days in July and August because water is lost through evaporation and the wind causes uneven water distribution. Efficiency is improved by watering in the evenings or on cool, calm days.

In a soil such as Wymore silty clay, 2 to 7 percent slopes, eroded, permeability and the rate of water intake are slow. Under clean cultivation and during the early stages of crop growth in spring, it is difficult to apply water at a rate slow enough for the soil to absorb it all. If a sprinkler system is used, the surface layer will become saturated and thus slow the downward movement of water. The soil will be subject to severe erosion during heavy rains. A combination of a conservation tillage system and terraces to control erosion is especially important if sprinkler irrigation is used in spring before a crop canopy has formed.

Sprinkler irrigation can be especially useful in conservation. It can be used to establish new crops or new pasture grasses on sloping soils or to water trees and shrubs in windbreaks.

On nearly level soils, a gravity or furrow irrigation system is suited to row crops. The principal nearly level soils in Johnson County are Kennebec silt loam, 0 to 1 percent slopes; Nodaway silt loam, 0 to 2 percent slopes; Wymore silty clay loam, 0 to 2 percent slopes; and Zook silty clay loam, 0 to 1 percent slopes. Land leveling is necessary for proper drainage. It also increases the efficiency of irrigation because it results in an even distribution of water throughout the field. In the flatter fields, the length of the rows and the run and the amount of water applied are determined mainly by the rate of water intake or permeability of the soils.

Soils suited to irrigation generally have a high available water capacity, or hold about 2 inches of available moisture per foot of soil. On these soils, a crop that utilizes moisture to a depth of 3 feet will have about 6 inches of available moisture. Maximum efficiency is obtained if irrigation is started when about half of the stored water has been used by the plants. Thus, if a soil holds 6 inches of available water, irrigation should be started when about 3 inches of the water has been used by the crop.

All the soils in Nebraska can be placed in an irrigation design group. These groups are described in an irrigation guide (*11*), which is part of the technical specifications for conservation in Nebraska. Assistance in planning and designing irrigation systems is available at the local office of the Soil Conservation Service or the Cooperative Extension Service.

Pasture

About 42,000 acres in Johnson County is used for pasture. Pastures of introduced grasses consist mainly of cool-season grasses, which start to grow early in the spring and reach peak growth in May or June. These grasses are dormant during July and August and start to grow again in the fall. As a result, it is desirable to have separate pastures of warm-season, native grasses or temporary pastures of sudangrass that attain peak growth during July and August. This combination of cool-season and warm-season grasses provides green plants during the entire growing season.

The best results are obtained if the grasses are grazed in rotation. Rotation grazing allows time for plant regrowth, extends forage quality during the grazing season, and improves livestock performance. It can be a part of a planned grazing system. For rotation grazing, one large pasture can be divided into two or more smaller pastures.

Smooth brome is the species most commonly grown on cool-season grass pastures. Other adapted cool-season grasses and legumes are orchardgrass, tall fescue, creeping foxtail, meadow bromegrass, birdsfoot trefoil, cicer milkvetch, intermediate wheatgrass, alfalfa, and reed canarygrass. If planted as a single species on nonirrigated land, some native, warm-season grasses, especially switchgrass, big bluestem, and indiangrass, can provide high-quality forage in the summer. Alfalfa generally should make up one-fourth or one-third of a legume-grass mixture.

Introduced pasture grasses are grazed in the spring and fall, after they reach a height of 5 or 6 inches. Until the plants reach this height, they grow on food reserves stored in their roots and rhizomes. Grazing too early in spring or too late in fall weakens the plants.

Introduced grasses respond to applications of fertilizer. The amount and kind of fertilizer to be applied should be based on soil tests and on estimates of the amount of available soil moisture. Applications of nitrogen generally are needed. If a legume is included, phosphate fertilizer generally is needed. Grasses and legumes are compatible with grain crops and are ideal for use in a conservation cropping system. They improve soil structure and tilth, add organic matter, increase the rate of water intake, and help to control erosion.

Yields Per Acre

The average yields per acre that can be expected of the principal dryland crops under average and high levels of management are shown in table 5. The expected yields of the principal irrigated crops under a high level of management are shown in table 6. In any given year, yields may be higher or lower than those indicated in the tables because of variations in rainfall and other climatic factors. The land capability classification of each map unit also is shown in the tables.

The yields are based mainly on the experience and records of farmers, conservationists, and extension

agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The high level of management needed to obtain the indicated yields in table 6 and in the B columns in table 5 can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green manure crops; and harvesting that ensures the smallest possible loss. Fertilizer and lime are applied at rates determined by soil tests and field experiments.

For yields of irrigated crops, it is assumed that the irrigation system is adapted to the soils and to the crops grown, that good quality irrigation water is uniformly applied as needed, and that tillage is kept to a minimum.

To obtain the yields shown in the A columns in table 5, an average level of management is needed. This management includes a moderate attempt to maintain fertility, but it does not necessarily include soil tests to determine the proper amount of fertilizer or the proper time of application. The most effective means of controlling erosion and maintaining tilth is not used. Measures that control weeds, disease, and insects are not consistently applied. Certified seed is not always used. Fieldwork is not always timely. Improved varieties of plants are not grown, and the proper plant populations are not necessarily maintained. Correcting these deficiencies is likely to result in significantly higher yields.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in tables 5 and 6 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils for those crops.

Prime Farmland

Prime farmland is one of several kinds of important farmland defined by the U.S. Department of Agriculture. It is of major importance in meeting the Nation's short- and long-range needs for food and fiber. Because the supply of high quality farmland is limited, the U.S. Department of Agriculture recognizes that responsible levels of government, as well as individuals, should encourage and facilitate the wise use of our Nation's prime farmland.

Prime farmland, as defined by the U.S. Department of Agriculture, is the land that is best suited to food, feed, forage, fiber, and oilseed crops. It may be cultivated land, pasture, woodland, or other land, but it is not urban and built-up land or water areas. It either is used for food or fiber crops or is available for those crops. The soil qualities, growing season, and moisture supply are those needed for a well managed soil to produce a sustained high yield of crops in an economic manner. Prime farmland produces the highest yields with minimal inputs of energy and economic resources, and farming it results in the least damage to the environment.

Prime farmland has an adequate and dependable supply of moisture from precipitation or irrigation. The temperature and growing season are favorable. The level of acidity or alkalinity is acceptable. Prime farmland has few or no rocks and is permeable to water and air. It is not excessively erodible or saturated with water for long periods and is not frequently flooded during the growing season. The slope ranges mainly from 0 to 6 percent. More detailed information about the criteria for prime farmland is available at the local office of the Soil Conservation Service.

About 116,731 acres in the survey area, or more than 48 percent of the total acreage, meets the soil requirements for prime farmland. Scattered areas of this land are throughout the county, but most are in associations 2 and 3, which are described under the heading "General Soil Map Units."

A recent trend in land use in some parts of the county has been the loss of some prime farmland to industrial and urban uses. The loss of prime farmland to other uses puts pressure on marginal lands, which generally are more erodible, droughty, and less productive and cannot be easily cultivated.

The map units in the survey area that are considered prime farmland are listed in table 7. This list does not constitute a recommendation for a particular land use. The extent of each listed map unit is shown in table 4. The location is shown on the detailed soil maps at the back of this publication. The soil qualities that affect use and management are described under the heading "Detailed Soil Map Units."

Some soils that have a seasonal high water table qualify for prime farmland only in areas where this limitation has been overcome by drainage measures. The need for these measures is indicated after the map unit name in table 7. Onsite evaluation is needed to determine whether or not this limitation has been overcome by corrective measures.

Land Capability Classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops,

the risk of damage if they are used for crops, and the way they respond to management. The criteria used in grouping the soils do not include major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor do they include possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for woodland, and for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit. These levels are defined in the following paragraphs.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have few limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is very cold or very dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w*, *s*, or *c* because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

Capability units are soil groups within a subclass. The soils in a capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIs-2 or IVe-4.

The acreage of soils in each capability class and subclass is shown in table 8. The capability classification of each map unit is given in the section "Detailed Soil Map Units" and in the yields tables.

Rangeland

Peter N. Jensen, range conservationist, and Howard Sautter, soil scientist, Soil Conservation Service, prepared this section.

About 13 percent of Johnson County, or 32,000 acres, is used for range. This acreage includes both native prairie never broken from sod and areas that once were cultivated but then were seeded to native grasses. Most of the range is on the glacial soils in the Pawnee-Morrill-Shelby association (fig. 8). These soils are strongly sloping to steep. A small acreage is meadow cut for prairie hay.

On most of the livestock farms in the county, the range is used for raising small herds of cows and calves. The calves are sold as feeders in fall. The cattle graze the range from late spring through early fall. They graze cool-season grasses, such as smooth brome, in the spring and corn or grain sorghum stalks in the fall and early winter. They are fed alfalfa hay, prairie hay, silage, or a combination of these for the rest of the winter.

Much of the range in the county has been depleted through continuous overgrazing. The major forage-producing plants, such as big bluestem, indiangrass, little bluestem, and switchgrass, are low in vigor and are less dominant than other plants. Overgrazed pastures commonly have a large amount of the less productive forage plants, weeds, shrubs, and trees. The productivity of range can be increased by the use of sound management practices, for example, proper grazing use, planned grazing systems, and brush and weed control. Range seeding can be used to convert cropland to range or to restore depleted range.

At the end of each map unit description in this survey, the soil is assigned to an appropriate range site, depending on the kind and amount of vegetation grown on the soil when the site is in climax condition. Interpretations for each range site in the county are given in the Technical Guide, which is available at the local office of the Soil Conservation Service. This office also can provide technical assistance in seeding cropland to grass and in setting up a planned grazing system.

In areas that have similar climate and topography, differences in the kind and amount of vegetation produced on rangeland are closely related to the kind of soil. Effective management is based on the relationship between the soils and vegetation and water.

Figure 8.—An area of Pawnee clay loam, 3 to 9 percent slopes, used for range.

Table 9 shows, for each soil, the range site; the total annual production of vegetation in favorable, normal, and unfavorable years; the characteristic vegetation; and the average percentage of each species. Only those soils that are used as rangeland or are suited to use as rangeland are listed. An explanation of the column headings in table 8 follows.

A *range site* is a distinctive kind of rangeland that produces a characteristic natural plant community that differs from natural plant communities on other range sites in kind, amount, and proportion of range plants. The relationship between soils and vegetation was ascertained during this survey; thus, range sites generally can be determined directly from the soil map. Soil properties that affect moisture supply and plant nutrients have the greatest influence on the productivity of range plants. Soil reaction, salt content, and a seasonal high water table are also important.

Total production is the amount of vegetation that can be expected to grow annually on well managed rangeland that is supporting the potential natural plant community. It includes all vegetation, whether or not it is palatable to grazing animals. It includes the current year's growth of leaves, twigs, and fruits of woody plants. It does not include the increase in stem diameter of trees and shrubs. It is expressed in pounds per acre of air-dry vegetation for favorable, normal, and unfavorable years. In a favorable year, the amount and distribution of precipitation and the temperatures make growing conditions substantially better than average. In a normal year, growing conditions are about average. In an unfavorable year, growing conditions are well below average, generally because of low available soil moisture.

Dry weight is the total annual yield per acre of air-dry vegetation. Yields are adjusted to a common percent of air-dry moisture content. The relationship of green weight to air-dry weight varies according to such factors as exposure, amount of shade, recent rains, and unseasonable dry periods.

Characteristic vegetation—the grasses, forbs, and shrubs that make up most of the potential natural plant

community on each soil—is listed by common name. Under *composition*, the expected percentage of the total annual production is given for each species making up the characteristic vegetation. The amount that can be used as forage depends on the kinds of grazing animals and on the grazing season.

Range management requires a knowledge of the kinds of soil and of the potential natural plant community. It also requires an evaluation of the present range condition. Range condition is determined by comparing the present plant community with the potential natural plant community on a particular range site. The more closely the existing community resembles the potential community, the better the range condition. Range condition is an ecological rating only.

The objective in range management is to control grazing so that the plants growing on a site are about the same in kind and amount as the potential natural plant community for that site. Such management generally results in the optimum production of vegetation, control of undesirable brush species, conservation of water, and control of erosion. Sometimes, however, a range condition somewhat below the potential meets grazing needs, provides wildlife habitat, and protects soil and water resources.

Woodland

Keith A. Ticknor, forester, Soil Conservation Service, prepared this section.

About 3 percent of Johnson County, or 7,000 acres, is forested. The forested acreage is decreasing, mainly because of the conversion to cropland or pasture. The woodland is in irregular tracts and narrow bands along streams and rivers, in strips in upland drainageways, and in blocks on steep upland soils, generally next to streams. It is divided into the bur oak forest cover type and the hackberry-American elm-green ash forest cover type.

The hackberry-American elm-green ash forest cover type generally is on bottom lands in the Nodaway-Zook-Judson soil association and on the upland drainageways extending into the Pawnee-Morrill-Shelby association. Associated species, especially eastern cottonwood and boxelder, are numerous. Other species are silver maple, black walnut, red mulberry, honeylocust, black willow, and American plum.

The bur oak forest cover type is in areas dissected by drainageways and on moderately steep and steep glacial soils in the Pawnee-Morrill-Shelby association. The most abundant associated species are hickories (shagbark, butternut, and mockernut). Some other species are American elm, hackberry, honeylocust, common chokecherry, American plum, gooseberry, green ash, and common pricklyash.

Many of the trees have commercial value for wood products. Only a small part of the woodland, however, is managed for commercial wood production. Wooded areas are mostly privately owned and make up only a small acreage of the farm units.

On many of the soils in the county, the potential is good for the production of veneer, sawtimber, Christmas trees, firewood, and other wood products. Most of these soils are used as cropland and are not likely to be converted to woodland. The soils on bottom lands in the river and stream valleys can produce high-value hardwoods within a short period. In contrast, the upland soils can produce only low-value, long-rotation trees.

Windbreaks and Environmental Plantings

Keith A. Ticknor, forester, Soil Conservation Service, prepared this section.

A high percentage of the farmsteads in Johnson County have trees around them. The trees were there when the farmstead was established, or they have been planted since then. Eastern redcedar and Siberian elm constitute a high percentage of these trees (fig. 9). Some of the other common trees or shrubs include lilac, Austrian pine, Scotch pine, green ash, black walnut, hackberry, northern catalpa, and boxelder.

New trees are needed around the farmsteads because old trees pass maturity and deteriorate and some trees are destroyed by disease or insects or by storms. Some new trees are needed in areas where the farmyard has been expanded.

Field windbreaks in the county are single hedgerows, generally of osageorange, that outline the farm or fields. They were grown as a living fence when the farms were first settled. Hedgerows are common throughout the county, but many have been removed because fields of cropland have been enlarged. In several places, chokecherry grows under the osageorange trees.

For windbreaks and environmental plantings to fulfill their intended purpose, the species of trees or shrubs that are adapted to the soils on the site should be selected for planting. Matching the appropriate trees and shrubs with the soil type helps to ensure survival and maximum growth. Permeability, available water capacity, fertility, drainage, and soil depth affect the survival and growth rates.

Trees and shrubs can be easily established on most of the soils in Johnson County. Plant competition for moisture, nutrients, and sunlight causes most failures in windbreak plantings. Proper site preparation before planting and controlling weeds and other competing plants after planting are the major concerns in establishing and managing windbreaks.

Windbreaks protect livestock, buildings, and yards from wind and snow. They also protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broadleaf and coniferous trees and shrubs provide the most protection.

Figure 9.—A farmstead windbreak of eastern redcedar in an area of Wymore silty clay loam, 2 to 7 percent slopes.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field. The interval depends on the erodibility of the soil. Field windbreaks protect cropland and crops from wind, help to keep snow on the fields, and provide food and cover for wildlife.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. To ensure plant survival, a healthy planting stock of suitable species should be planted properly on a well prepared site and maintained in good condition.

Table 10 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils. The estimates in table 10 are based on measurements and observation of established plantings that have been given adequate care. They can be used as a guide in planning windbreaks and screens.

At the end of each map unit description, the soil has been assigned to a windbreak suitability group. These groups are based primarily on the suitability of the soil for the locally adapted species, as is indicated by their growth and vigor. Detailed interpretations for each windbreak suitability group in the county are provided in the Technical Guide, which is available in the local office of the Soil Conservation Service.

Additional information on planning windbreaks and screens and planting and caring for trees and shrubs can be obtained from local offices of the Soil Conservation Service or the Cooperative Extension Service or from a commercial nursery.

Recreation

Robert O. Koerner, biologist, Soil Conservation Service, prepared this section

Eleven kinds of private recreation areas have been evaluated by representatives of county, state, and federal agencies, as well as by local private organizations. These areas were vacation cottages and homesites; camping areas; picnic and sports areas; fishing waters; golf courses; hunting areas; natural,

scenic, and historic areas; riding stables; shooting preserves; vacation farms and ranches; and water sports areas.

Most of the recreation enterprises had some potential for future development. The ratings were medium for all enterprises, except for small game hunting, which was rated high because of the abundance of bobwhite quail in the county.

Two wildlife management areas in the county are accessible to the public for hunting eligible species during regular seasons. The areas are the 481-acre Osage Wildlife Management Area and the 784-acre Twin Oaks Wildlife Management Area. They are owned by the Nebraska Game and Parks Commission. Openland game and big game can be hunted on private land during regular seasons if permission is granted.

Largemouth bass, bluegills, and catfish inhabit the private ponds. Scattered throughout the county are 465 farm ponds, covering an estimated 650 surface acres. Stream fishing is also available, as follows: North Fork of the Big Nemaha River (catfish, bullheads, and carp), South Fork of the Little Nemaha River (catfish, bullheads, and carp), Spring Creek (bullheads), and Yankee Creek (bullheads).

A golf course is about 2 miles west of Tecumseh, along U.S. Highway 136. Most towns, such as Tecumseh, Cook, and Sterling, have small parks and picnic areas.

The soils of the survey area are rated in table 11 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewerlines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 11, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 11 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 14 and interpretations for dwellings without basements and for local roads and streets in table 13.

Camp areas require site preparation, such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or a hardpan should be considered.

Paths and trails for hiking and horseback riding should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

Wildlife Habitat

Howard Sautter, soil scientist, and Robert O. Koerner, biologist, Soil Conservation Service, prepared this section

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

In table 12, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are grain sorghum, wheat, oats, and soybeans.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are smooth bromegrass, red canarygrass, alfalfa, and red clover.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are bluestem, sunflowers, switchgrass, smartweed, giant ragweed, and foxtail.

Hardwood trees and woody understory produce nuts or other fruit, buds, catkins, twigs, bark, and foliage. Soil properties and features that affect the growth of hardwood trees and shrubs are depth of the root zone, available water capacity, and wetness. Examples of these plants are oak, cottonwood, chokecherry, wild plum, gooseberry, black walnut, and mulberry. Examples of fruit-producing shrubs that are suitable for planting on soils rated *good* are Russian-olive, autumn-olive, and skunkbush sumac.

Coniferous plants furnish browse and seeds. Soil properties and features that affect the growth of coniferous trees, shrubs, and ground cover are depth of the root zone, available water capacity, and wetness. Examples of coniferous plants are pine, cedar, and juniper.

Shrubs are bushy woody plants that produce fruit, buds, twigs, bark, and foliage. Soil properties and features that affect the growth of shrubs are depth of the root zone, available water capacity, salinity, and soil moisture. Examples of shrubs are American plum, chokecherry, buckbrush, and sumac.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, reed canarygrass, cordgrass, rushes, sedges, and cattails.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The habitat for various kinds of wildlife is described in the following paragraphs.

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The wildlife attracted to these areas include bobwhite quail, pheasant, meadowlark, field sparrow, cottontail, mourning dove, killdeer, and coyote.

Habitat for woodland wildlife consists of areas of deciduous plants or coniferous plants or both and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include songbirds, woodpeckers, squirrels, opossum, raccoons, whitetail deer, and skunks.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, shore birds, muskrat, mink, and beaver.

Habitat for rangeland wildlife consists of areas of shrubs and wild herbaceous plants. Wildlife attracted to rangeland include coyote, whitetail deer, and meadowlark.

Of the kinds of wildlife common when the survey area was settled, some vanished when the natural grass vegetation was replaced by cultivated crops and others became more abundant. Deer are the only hoofed animals remaining of a wildlife population that once included antelope, elk, and buffalo. Prairie chicken was

once the main upland bird, but now only a few protected flocks are in the county, in the southwestern part. Bobwhite quail and ring-necked pheasant benefited greatly from the conversion of range to cropland. Beaver, which were scarce for a number of years, are now plentiful.

The following paragraphs describe the wildlife and the habitat in the three soil associations in Johnson County.

The Wymore association makes up about 25 percent of the county. It is characterized by cultivated fields on nearly level divides, gently sloping ridges, and side slopes at some of the highest elevations in the county. This association is drained by small waterways. It has the largest population of ring-necked pheasant in the county. Other openland wildlife species are mourning dove and cottontail rabbit. Mourning dove and several kinds of songbirds inhabit these areas during the migrating seasons. Waste from grain crops provides food, and fields of alfalfa, grassed waterways, and roadside ditches provide nesting areas and travel lanes.

The Nodaway-Zook-Judson association makes up about 15 percent of the county. It is the most important wildlife habitat in the county because of the kind and amount of wildlife species that it supports. It consists of nearly level and gently sloping soils on foot slopes, stream terraces, and bottom lands at the lowest elevations in the county. It includes the drainageways of the North Fork of the Big Nemaha River, the South Fork of the Little Nemaha River, and numerous tributaries of these streams. The channels and immediate streambanks provide habitat for furbearers, such as mink, beaver, and muskrat. The bottom lands adjacent to the streams are used mostly for grain crops. Openland wildlife species include bobwhite quail, ring-necked pheasant, mourning dove, cottontail, hawks, and coyote. Wooded tracts support woodland wildlife species, such as whitetail deer, squirrels, woodpeckers, and owls, and furbearers, such as opossum, raccoon, and skunks (fig. 10).

The Pawnee-Morrill-Shelby association makes up about 60 percent of the county. It is intermediate in topographic position between the higher Wymore association and the lower Nodaway-Zook-Judson association. It consists of gently sloping to steep soils, and it is characterized by terraced grain fields and pastures interspersed with native grassland and woodland. Small areas of bottom lands along drainageways extend into this association. Travel lanes for wildlife are numerous between low valleys and high ridges. Many species of wetland, woodland, and openland wildlife inhabit this association. These include whitetail deer, bobwhite quail, ring-necked pheasant, mourning dove, cottontail, coyote, squirrels, hawks, owls, and furbearers, such as beaver, muskrat, opossum, raccoon, and skunks. Waterfowl use the farm ponds during spring and fall migrations.

Engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil Properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations need to be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 to 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to (1) evaluate the potential of areas for residential, commercial, industrial, and recreation uses; (2) make preliminary estimates of construction conditions; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; (5) plan detailed onsite investigations of soils and geology; (6) locate potential sources of gravel, sand, earthfill, and topsoil; (7) plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and (8) predict performance of proposed small structures and pavements by comparing the

Figure 10.—Woodland wildlife habitat in an area of the Nodaway-Zook-Judson association.

performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

Building Site Development

Table 13 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, local roads and streets, and lawns and landscaping. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and

observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock, a cemented pan, or a very firm dense layer; stone content; soil texture; and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and the depth to the water table.

Dwellings and small commercial buildings are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic layers can cause the movement of footings. A high water table, depth to bedrock or to a cemented pan, large stones, slope, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 to 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock or to a cemented pan, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic supporting capacity.

Lawns and landscaping require soils on which turf and ornamental trees and shrubs can be established and maintained. The ratings are based on soil properties, site features, and observed performance of the soils. Soil reaction, a high water table, depth to bedrock or to a cemented pan, the available water capacity in the upper 40 inches, and the content of salts, sodium, and sulfidic materials affect plant growth. Flooding, wetness, slope, stoniness, and the amount of sand, clay, or organic matter in the surface layer affect trafficability after vegetation is established.

Sanitary Facilities

Table 14 shows the degree and kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 14 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock or to a cemented pan, and flooding affect absorption of the effluent. Large stones and bedrock or a cemented pan interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to filter the effluent effectively. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 14 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock or to a cemented pan, flooding, large stones, and content of organic matter.

Excessive seepage due to rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope, bedrock, and cemented pans can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 14 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock or to a cemented pan, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to soil blowing.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock, a cemented pan, or the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

Construction Materials

Table 15 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a *probable* or *improbable* source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and the depth to the water table is less than 1 foot. They may have layers of suitable material, but the material is less than 3 feet thick.

Sand and gravel are natural aggregates suitable for commercial use with a minimum of processing. Sand and gravel are used in many kinds of construction. Specifications for each use vary widely. In table 15, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the

thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

Water Management

Table 16 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas and for embankments, dikes, and levees. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, irrigation, terraces and diversions, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock, to a cemented pan, or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers; and potential frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock or to a cemented pan, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity or by toxic substances in the root zone, such as salts, sodium, or sulfur. Availability of drainage outlets is not considered in the ratings.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock or to a

cemented pan. The performance of a system is affected by the depth of the root zone, the amount of salts or sodium, and soil reaction.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to reduce erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock or to a cemented pan affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of soil blowing or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock or to a cemented pan affect the construction of grassed waterways. A hazard of soil blowing, low available water capacity, restricted rooting depth, toxic substances such as salts or sodium, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

Soil Properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics. These results are reported in table 20.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classifications, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

Engineering Index Properties

Table 17 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil Series and Their Morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter (fig. 11). "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is as much as about 15 percent, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

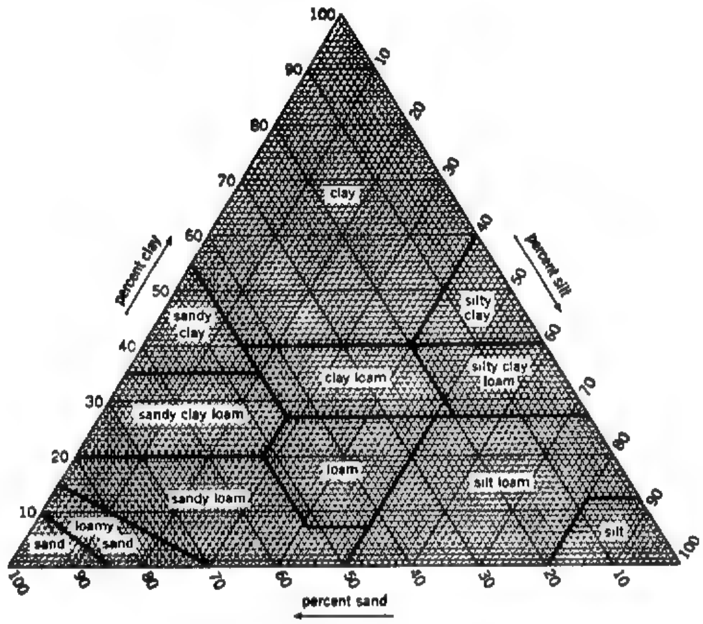


Figure 11.—Percentages of clay, silt, and sand in the basic USDA soil textural classes.

Classification of the soils is determined according to the Unified soil classification system (*2*) and the system adopted by the American Association of State Highway and Transportation Officials (*1*).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, CL-ML.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in

group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest. The AASHTO classification for soils tested, with group index numbers in parentheses, is given in table 20.

Rock fragments larger than 3 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

The estimates of grain-size distribution, liquid limit, and plasticity index are generally rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterberg limits extend a marginal amount (1 or 2 percentage points) across classification boundaries, the classification in the marginal zone is omitted in the table.

Physical and Chemical Properties

Table 18 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, permeability, and plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earthmoving operations.

Moist bulk density is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at 1/3 bar moisture tension. Weight is determined after drying the soil at 105 degrees C. In this table, the estimated moist bulk density of each major soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. A bulk density of more than 1.6 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Salinity is a measure of soluble salts in the soil at saturation. It is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25 degrees C. Estimates are based on field and laboratory measurements at representative sites of nonirrigated soils. The salinity of irrigated soils is affected by the quality of the irrigation water and by the frequency of water application. Hence, the salinity of soils in individual fields can differ greatly from the value given in the table. Salinity affects the suitability of a soil for crop production, the stability of soil if used as construction material, and the potential of the soil to corrode metal and concrete.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume

change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value, the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to soil blowing in cultivated areas. The groups indicate the susceptibility to soil blowing. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are generally not suitable for crops. They are extremely erodible, and vegetation is difficult to establish.

2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible. Crops can be grown if intensive measures to control soil blowing are used.

3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control soil blowing are used.

4L. Calcareous loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible. Crops can be grown if intensive measures to control soil blowing are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control soil blowing are used.

5. Loamy soils that are less than 18 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible. Crops can be grown if measures to control soil blowing are used.

6. Loamy soils that are 18 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible. Crops can easily be grown.

7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible. Crops can easily be grown.

8. Stony or gravelly soils and other soils not subject to soil blowing.

Organic matter is the plant and animal residue in the soil at various stages of decomposition. In table 18, the estimated content of organic matter is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter of a soil can be maintained or increased by returning crop residue to the soil. Organic matter affects the available water capacity, infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

Soil and Water Features

Table 19 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the intake of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to two hydrologic groups in table 19, the first letter is for drained areas and the second is for undrained areas.

Flooding, the temporary inundation of an area, is caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt is not considered flooding, nor is water in swamps and marshes.

Table 19 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *occasional* that it occurs, on the average, once or less in 2 years; and *frequent* that it occurs, on the average, more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; November-May, for example, means that flooding can occur during the period November through May.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 19 are the depth to the seasonal high water table; the kind of water table—that is, perched or apparent; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 19. Only saturated zones within a depth of about 6 feet are indicated.

An *apparent* water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. A *perched* water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Depth to bedrock is given if bedrock is within a depth of 5 feet. The depth is based on many soil borings and on observations during soil mapping. The rock is either soft or hard. If the rock is soft or fractured, excavations can be made with trenching machines, backhoes, or small rippers. If the rock is hard or massive, blasting or special equipment generally is needed for excavation.

Potential frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured clayey soils that have a high water table in winter are the most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage mainly to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low*, *moderate*, or *high*, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low*, *moderate*, or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

Physical and Chemical Analyses of Selected Soils

Samples from some soil profiles were collected and sent to the Soil Conservation Service, National Soil Survey Laboratory, in Lincoln, Nebraska, for physical and chemical analyses. Pawnee, Mayberry, Morrill, and Zoe soils in Johnson County were sampled for analysis during the course of the survey. Burchard, Morrill, Pawnee, Sharpsburg, and Wymore soils in nearby counties were also sampled (*10*). Data on Mayberry soils in this sampling were published under Adair soils. Data on Shelby soils also have been published (*9*). These data and other information on the soils in the county are available at the National Soil Survey Laboratory.

Other data on some soils in the county are also available. These soils were sampled for laboratory analysis by the Department of Agronomy, College of Agriculture, Institute of Agriculture and Natural Resources, University of Nebraska-Lincoln.

The laboratory methods of both the National Soil Survey Laboratory and the Nebraska Department of Roads Laboratory were used in determining soil properties. The National Soil Survey Laboratory develops data for the classification and agricultural management of soils. The Nebraska Department of Roads develops engineering test data. Much of the data can be extrapolated from one use to the other.

Engineering Index Test Data

Table 20 shows laboratory test data for several pedons sampled at carefully selected sites in the survey area. The pedons are representative of the series described in the section "Soil Series and Their Morphology." The soil samples were tested by the Nebraska Department of Roads.

The testing methods generally are those of the American Association of State Highway and Transportation Officials (AASHTO) or the American Society for Testing and Materials (ASTM).

The tests and methods are AASHTO classification—M 145 (AASHTO), D 3282 (ASTM); Unified classification—D 2487 (ASTM); Mechanical analysis—T 88 (AASHTO), D 2217 (ASTM); Liquid limit—T 89 (AASHTO), D 423 (ASTM); Plasticity index—T 90 (AASHTO), D 424 (ASTM); and Specific gravity—T 100 (AASHTO). The group index number that is part of the AASHTO classification is computed by the Nebraska modified system.

Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (*12*). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. Table 21 shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Mollisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Udoll (*Ud*, meaning humid, plus *oll*, from Mollisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Argiudolls (*Argi*, meaning a horizon of clay accumulation, plus *udoll*, the suborder of the Mollisols that have a udic moisture regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that typifies the great group. An example is Typic Argiudolls.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Mostly the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine, montmorillonitic, mesic Typic Argiudolls.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the underlying material can differ within a series.

Soil Series and Their Morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. The soil is compared with similar soils and with nearby soils of other series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the *Soil Survey Manual* (*8*). Many of the technical terms used in the descriptions are defined in *Soil Taxonomy* (*12*). Unless otherwise stated, colors in the descriptions are for moist soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed Soil Map Units."

Benfield Series

The Benfield series consists of moderately deep, well drained, slowly permeable soils on uplands. These soils formed in calcareous shale residuum. Slopes range from 11 to 25 percent.

These soils formed under a more humid climate than is definitive for the Benfield series. This difference, however, does not alter the usefulness or behavior of the soils.

Benfield soils are commonly adjacent to Kipson soils. The adjacent soils are shallow to shale and are

calcareous at the surface. They are in the same landscape positions as the Benfield soils.

Typical pedon of Benfield silty clay loam, in an area of Kipson-Benfield complex, 11 to 25 percent slopes, 175 feet north and 1,550 feet west of the southeast corner of sec. 36, T. 4 N., R. 11 E.

A—0 to 10 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; moderate very fine and fine subangular blocky structure; friable, hard; about 2 percent gravel; neutral; clear smooth boundary.

Bt1—10 to 15 inches; dark brown (10YR 3/3) silty clay loam, brown (10YR 4/3) dry; moderate very fine and fine subangular blocky structure; friable; about 2 percent gravel; neutral; clear smooth boundary

Bt2—15 to 21 inches; brown (7.5YR 4/4) silty clay, yellowish brown (10YR 5/4) dry; weak fine subangular blocky structure; firm; neutral; clear smooth boundary.

Bt3—21 to 29 inches; dark yellowish brown (10YR 4/4) silty clay, yellowish brown (10YR 5/4) dry; weak fine and medium subangular blocky structure; firm; mildly alkaline, clear smooth boundary.

BC—29 to 36 inches; light olive brown (2.5Y 5/4) silty clay loam, pale yellow (2.5Y 7/4) dry; few fine faint yellowish brown (10YR 5/6) mottles; weak medium angular blocky structure; firm; common large calcium carbonate concretions; few pieces of limestone; strong effervescence; moderately alkaline; gradual smooth boundary

Cr—36 to 60 inches; light yellowish brown (2.5Y 6/4) bedded shale, pale yellow (2.5Y 7/4) dry; massive; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to free carbonates range from 20 to 40 inches. The mollic epipedon is 7 to 20 inches thick.

The A horizon has value of 2 or 3 (4 or 5 dry) and chroma of 1 or 2. It is silty clay loam, silt loam, or loam. It ranges from slightly acid to mildly alkaline. The Bt horizon has hue of 5YR, 7.5YR, 10YR, or 2.5Y, value of 3 to 5 (4 to 6 dry), and chroma of 2 to 6. It is silty clay loam or silty clay. The C horizon, which reflects the color of the underlying shale, has hue of 5YR to 5Y, value of 5 or 6 (6 or 7 dry), and chroma of 2 to 4. It is mildly alkaline or moderately alkaline.

Burchard Series

The Burchard series consists of deep, well drained, moderately slowly permeable soils on uplands. These soils formed in loamy, calcareous glacial till. Slopes range from 9 to 15 percent.

Burchard soils are similar to Morrill and Shelby soils and are commonly adjacent to Dickinson, Pawnee, Shelby, and Steinauer soils. Morrill and Shelby soils have carbonates below a depth of 30 inches Dickinson soils formed in sandy material. They are in positions on the landscape similar to those of the Burchard soils. Pawnee soils have more clay in the B horizon than the Burchard soils. Also, they are higher on the landscape. Steinauer soils do not have an argillic horizon and have carbonates at the surface. They are in positions on the landscape similar to those of the Burchard soils.

Typical pedon of Burchard clay loam (fig. 12), in an area of Burchard-Steinauer clay loams, 9 to 15 percent slopes, eroded, 1,675 feet west and 200 feet north of the southeast corner of sec. 23, T. 4 N., R. 9 E.

Ap—0 to 5 inches; very dark grayish brown (10YR 3/2) clay loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; friable, hard; about 5 percent gravel; neutral; clear smooth boundary.

Bt1—5 to 9 inches; dark brown (10YR 3/3) clay loam, brown (10YR 4/3) dry; moderate fine subangular blocky structure; firm; neutral; clear smooth boundary.

Bt2—9 to 13 inches; brown (10YR 4/3) clay loam, pale brown (10YR 6/3) dry; moderate fine subangular blocky structure; firm; strong effervescence; moderately alkaline; clear smooth boundary.

BCk—13 to 25 inches; grayish brown (10YR 5/2) clay loam, light gray (10YR 7/2) dry; few medium distinct dark yellowish brown (10YR 4/4) mottles; moderate medium subangular blocky structure; firm; common medium soft accumulations of calcium carbonates; violent effervescence; moderately alkaline; clear smooth boundary.

C—25 to 60 inches; light brownish gray (10YR 6/2) clay loam, light gray (2.5Y 7/2) dry; common medium distinct dark yellowish brown (10YR 4/4) mottles; massive; many angular cleavage planes; firm; few seams and pockets of soft calcium carbonates; strong effervescence; moderately alkaline.

The solum is about 24 to 40 inches thick. The mollic epipedon is 8 to 18 inches thick. The depth to free carbonates ranges from 9 to 30 inches. The content of pebbles and cobblestones on the surface and in the profile ranges from 1 to 10 percent.

The A horizon has value of 2 or 3 (4 or 5 dry) and chroma of 1 or 2. It is dominantly clay loam, but the range includes loam. This horizon is slightly acid or neutral. The Bt horizon has value of 3 to 5 (4 to 7 dry) and chroma of 2 to 4. The C horizon has value of 5 or 6 (6 or 7 dry) and chroma of 2 to 6. The calcium carbonate equivalent in the calcareous part of the B horizon and in the C horizon ranges from 7 to 15 percent.

Dickinson Series

The Dickinson series consists of deep, well drained and somewhat excessively drained soils on uplands. These soils formed in loamy and sandy material.

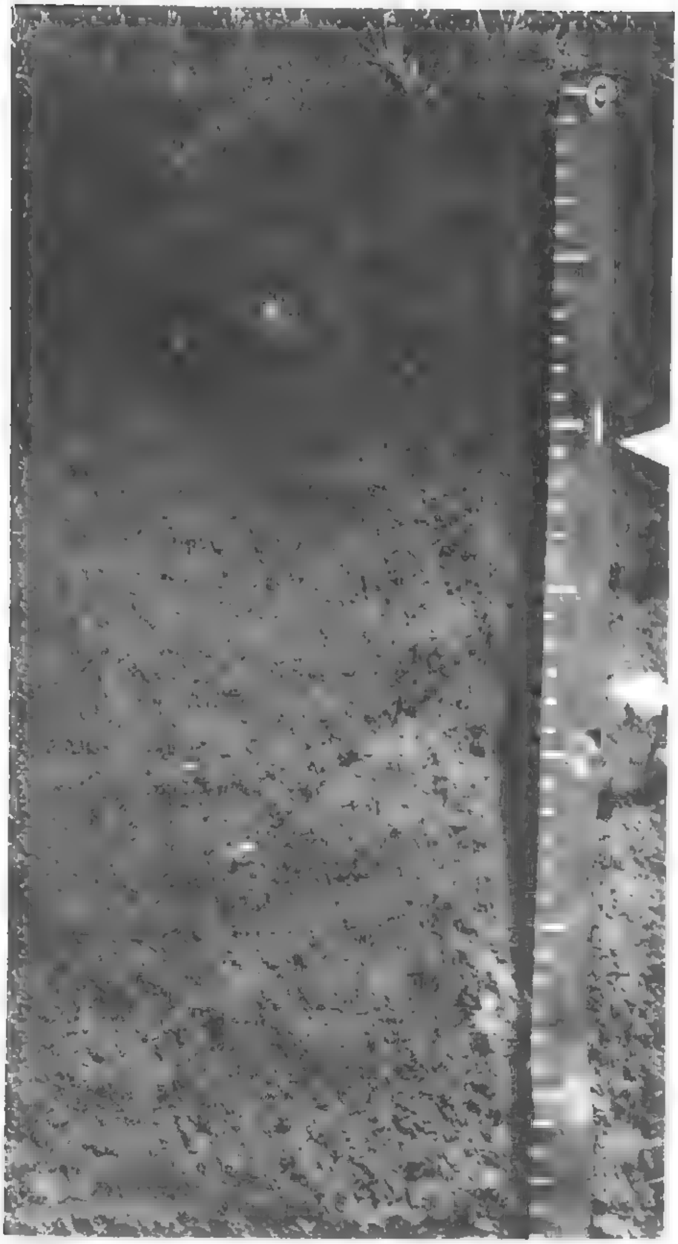


Figure 12.—Profile of Burchard clay loam. The upper arrow indicates the base of the mollic epipedon. The lower arrow indicates the subsoil. Depth is marked in feet.

Permeability is moderately rapid in the solum and rapid in the underlying material. Slopes range from 6 to 20 percent.

Dickinson soils are commonly adjacent to Burchard, Malcolm, Mayberry, Morrill, and Shelby soils. The adjacent soils have less sand than the Dickinson soils. They are in the same general landscape positions as the Dickinson soils.

Typical pedon of Dickinson fine sandy loam, 6 to 11 percent slopes, 175 feet south and 2,400 feet east of the northwest corner of sec. 16, T. 6 N., R. 12 E.

A1—0 to 18 inches; very dark brown (10YR 2/2) fine sandy loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; very friable, soft; medium acid; gradual smooth boundary.

BA—18 to 24 inches; very dark grayish brown (10YR 3/2) fine sandy loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; very friable; medium acid; clear smooth boundary.

Bw—24 to 32 inches; dark brown (10YR 4/3) fine sandy loam, brown (10YR 5/3) dry; weak medium subangular blocky structure; very friable; slightly acid; clear smooth boundary.

BC—32 to 37 inches; brown (10YR 5/3) loamy fine sand, pale brown (10YR 6/3) dry; weak medium subangular blocky structure; very friable; slightly acid; clear smooth boundary.

C—37 to 60 inches; pale brown (10YR 6/3) fine sand, very pale brown (10YR 7/3) dry; single grain; loose; slightly acid.

The solum is 24 to 45 inches thick. It is medium acid or slightly acid. The mollic epipedon is 10 to 24 inches thick.

The A horizon has value of 2 or 3 (4 or 5 dry) and chroma of 1 or 2. It is dominantly fine sandy loam, but the range includes sandy loam and loam. Some pedons do not have a BA horizon. The Bw horizon has hue of 10YR or 7.5YR, value of 3 to 5 (5 or 6 dry), and chroma of 2 to 4. The BC and C horizons have hue of 10YR or 7.5YR, value of 5 or 6 (6 or 7 dry), and chroma of 3 to 6. The BC and C horizons are loamy fine sand, fine sand, or sand.

Judson Series

The Judson series consists of deep, well drained, moderately permeable soils on foot slopes and stream terraces. These soils formed in silty sediments that eroded from dark soils on the adjacent uplands. Slopes range from 2 to 6 percent.

Judson soils are similar to Kennebec soils and are commonly adjacent to Kennebec, Nodaway, Pawnee, Shelby, and Wymore soils. Kennebec soils are grayer below a depth of 30 inches than the Judson soils. Also, they are lower on the landscape. Nodaway soils are stratified and are on bottom lands. Pawnee, Shelby, and Wymore soils have a mollic epipedon that is thinner than that of the Judson soils. They are on uplands. Pawnee and Shelby soils formed in glacial till, and Wymore soils formed in loess.

Typical pedon of Judson silt loam, 2 to 6 percent slopes, 625 feet north and 125 feet east of the southwest corner of sec. 6, T. 6 N., R. 12 E.

Ap—0 to 10 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; weak medium subangular blocky structure parting to weak very fine granular; friable, slightly hard; slightly acid; clear smooth boundary.

A1—10 to 13 inches; black (10YR 2/1) silty clay loam, very dark grayish brown (10YR 3/2) dry; weak medium subangular blocky structure parting to weak fine granular; friable; slightly acid; clear smooth boundary.

A2—13 to 24 inches; very dark brown (10YR 2/2) silty clay loam, dark grayish brown (10YR 4/2) dry; moderate very fine subangular blocky structure; friable; neutral; gradual smooth boundary.

BA—24 to 36 inches; dark brown (10YR 3/3) silty clay loam, dark brown (10YR 4/3) dry; faces of peds very dark brown (10YR 2/2) and dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; friable; neutral; gradual smooth boundary.

Bw—36 to 54 inches; brown (10YR 4/3) silty clay loam, brown (10YR 5/3) dry; faces of peds very dark grayish brown (10YR 3/2) and grayish brown (10YR 5/2) dry; moderate medium and fine subangular blocky structure; friable; neutral; gradual smooth boundary.

C—54 to 60 inches; brown (10YR 4/3) silty clay loam, pale brown (10YR 6/3) dry; faces of peds very dark grayish brown (10YR 3/2) and brown (10YR 5/3) dry; weak medium prismatic structure; friable; neutral.

The solum is 40 to 60 inches thick. The mollic epipedon is 30 to more than 50 inches thick. Beginning at a depth of 36 inches or less, the interior of the peds has value of 3 or 4 (4 to 6 dry) and chroma of 3 or 4. In some pedons, value is 3 to a depth of 60 inches.

The A horizon is 20 to 36 inches thick. It is silt loam or silty clay loam and is slightly acid or neutral.

Kennebec Series

The Kennebec series consists of deep, moderately well drained, moderately permeable soils on bottom lands. These soils formed in silty alluvium. Slopes range from 0 to 4 percent.

Kennebec soils are similar to Judson soils and are commonly adjacent to Judson, Nodaway, and Zook soils. Judson soils are browner below a depth of 30 inches than the Kennebec soils. They are on foot slopes upslope from the Kennebec soils. Nodaway soils do not have a mollic epipedon. They are lower on the landscape than the Kennebec soils. Zook soils are poorly drained and have more clay than the Kennebec soils. Also, they are lower on the landscape.

Typical pedon of Kennebec silt loam, 0 to 1 percent slopes, 75 feet south and 850 feet west of the northeast corner of sec. 18, T. 5 N., R. 10 E.

Ap—0 to 8 inches; very dark gray (10YR 3/1) silt loam, dark grayish brown (10YR 4/2) dry; weak fine crumb structure; friable, slightly hard; neutral; clear smooth boundary.

A1—8 to 28 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; moderate fine granular structure; friable; slightly acid; gradual smooth boundary.

AC—28 to 39 inches; very dark gray (10YR 3/1) silt loam, dark grayish brown (10YR 4/2) dry; moderate fine subangular blocky structure; friable; neutral; gradual smooth boundary.

C—39 to 60 inches; very dark grayish brown (10YR 3/2) silty clay loam, grayish brown (10YR 5/2) dry; few fine distinct dark yellowish brown (10YR 4/4) mottles; weak medium prismatic structure; friable; grayish coatings on faces of peds; neutral; gradual smooth boundary.

The solum is 36 to more than 50 inches thick. It is slightly acid or neutral. The mollic epipedon is more than 36 inches thick.

The A horizon has value of 2 or 3 (4 or 5 dry) and chroma of 1 or 2. It is dominantly silt loam, but the range includes silty clay loam. The C horizon has value of 3 or 4 (4 or 5 dry) and chroma of 1 or 2. It is dominantly silt loam or silty clay loam.

Kipson Series

The Kipson series consists of shallow, somewhat excessively drained, moderately permeable soils on uplands. These soils formed in calcareous shale residuum. Slopes range from 11 to 25 percent.

These soils formed under a more humid climate than is definitive for the Kipson series. This difference, however, does not alter the usefulness or behavior of the soils.

Kipson soils are commonly adjacent to Benfield, Mayberry, Morrill, and Pawnee soils. Benfield soils are deeper to shale than the Kipson soils. They are in the same landscape positions as the Kipson soils. Mayberry, Morrill, and Pawnee soils formed in glacial till, are deeper than the Kipson soils, and are higher on the landscape.

Typical pedon of Kipson flaggy silty clay loam, in an area of Kipson-Benfield complex, 11 to 25 percent slopes, 50 feet north and 2,000 feet west of the southeast corner of sec. 36, T. 4 N., R. 11 E.

A—0 to 7 inches; very dark grayish brown (10YR 3/2) flaggy silty clay loam, dark grayish brown (10YR 4/2) dry; moderate medium granular structure; friable, hard; about 20 percent mostly flat limestone fragments (10 percent 6 to 15 inches long, 5 percent 3 to 6 inches long, and 5 percent less than 3 inches in diameter); violent effervescence; moderately alkaline; clear smooth boundary.

AC—7 to 13 inches; dark grayish brown (10YR 4/2) channery silty clay loam, brown (10YR 5/3) dry; moderate fine subangular blocky structure; friable; about 25 percent limestone fragments less than 3 inches in size; violent effervescence; moderately alkaline; clear smooth boundary.

C—13 to 18 inches; olive brown (2.5Y 4/4) silty clay loam, light yellowish brown (10YR 6/4) dry; massive; about 15 percent small limestone fragments; violent effervescence; moderately alkaline; gradual smooth boundary.

Cr1—18 to 28 inches; mixed olive (5Y 5/3) and weak red (2.5YR 4/2), weathered, bedded shale, pale olive (5Y 6/3) and reddish brown (2.5YR 5/4) dry; clear wavy boundary.

Cr2—28 to 40 inches; weak red (2.5YR 4/2), consolidated, bedded shale.

The solum is 8 to 20 inches thick. The A horizon has value of 2 or 3 (4 or 5 dry) and chroma of 1 or 2. It is dominantly flaggy silty clay loam, but the range includes silt loam and silty clay loam. The content of coarse fragments as much as 6 inches in size ranges from 0 to 25 percent. The content of flagstones more than 6 inches in size ranges from 0 to 15 percent. The AC horizon has hue of 2.5YR to 2.5Y. It is loam, silty clay loam, or the channery analogs of these textures. The C and Cr horizons have hue of 2.5YR to 5Y, value of 4 or 5 (5 or 6 dry), and chroma of 2 to 4. The C horizon is shaly silt loam, shaly silty clay loam, or silty clay loam.

Malcolm Series

The Malcolm series consists of deep, well drained and somewhat excessively drained, moderately permeable soils on uplands. These soils formed in silty deposits (fig. 13). Slopes range from 5 to 25 percent.

Malcolm soils are commonly adjacent to Dickinson, Mayberry, and Morrill soils. Dickinson soils formed in sandy material. They are in the same general landscape position as the Malcolm soils. Mayberry and Morrill soils are commonly higher on the landscape than the Malcolm soils. Also, Mayberry soils have redder hue and more clay in the subsoil, and Morrill soils have redder hue and more sand.

Typical pedon of Malcolm silt loam, 11 to 25 percent slopes, 1,050 feet south and 350 feet west of the northeast corner of sec. 25, T. 6 N., R. 11 E.

A—0 to 12 inches; very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) dry; moderate fine granular structure; friable; medium acid; gradual smooth boundary.

Bt1—12 to 17 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; moderate fine subangular blocky structure; friable; slightly acid; few pebbles; clear smooth boundary.

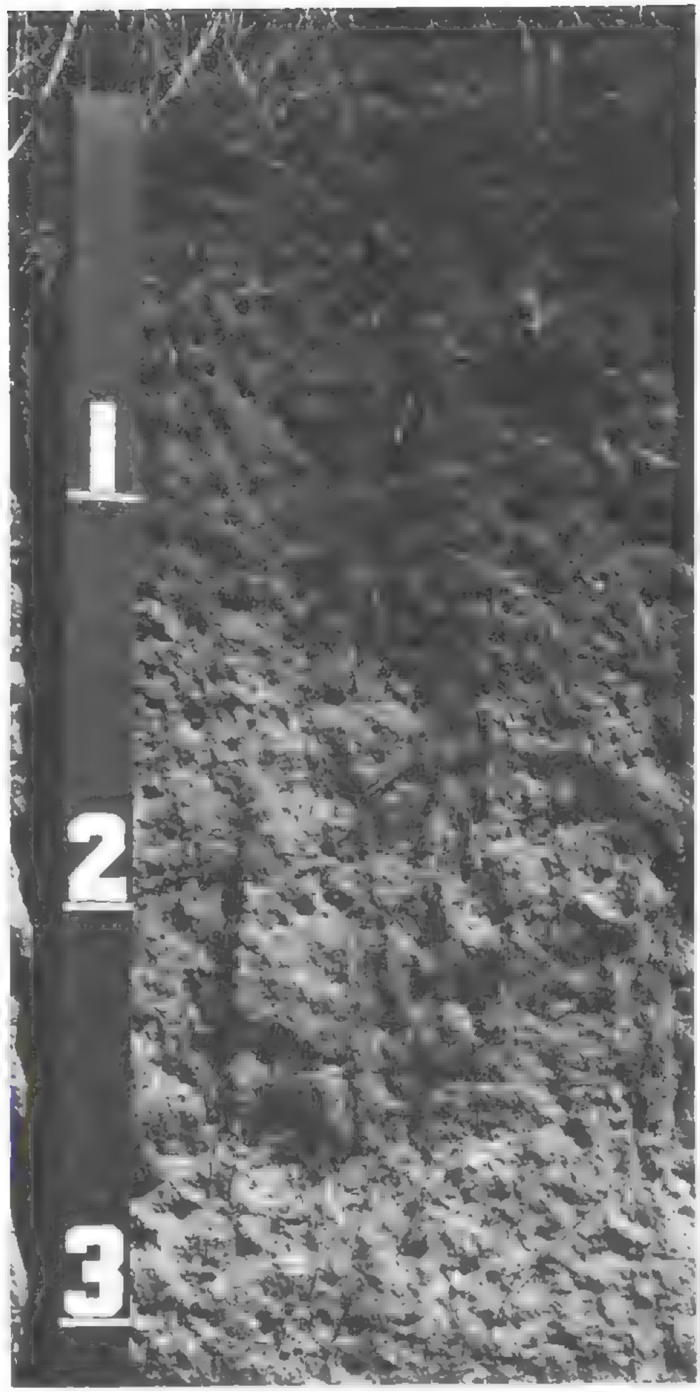


Figure 13.—Profile of Malcolm silt loam. Depth is marked in feet.

Bt2—17 to 23 inches; dark brown (10YR 4/3) silty clay loam, brown (10YR 5/3) dry; moderate fine subangular blocky structure; friable; slightly acid; gradual smooth boundary.

BC—23 to 30 inches; light olive brown (2.5Y 5/3) silty clay loam, light yellowish brown (2.5Y 6/3) dry; few fine faint dark yellowish brown (10YR 4/4) mottles; moderate fine subangular blocky structure; friable; slightly acid; gradual smooth boundary.

C1—30 to 40 inches; light yellowish brown (10YR 6/4) silt loam, pale yellow (2.5Y 7/3) dry; weak medium and fine subangular blocky structure; friable; slightly acid; gradual smooth boundary.

C2—40 to 65 inches; light brownish gray (2.5Y 6/2) silt loam, white (2.5Y 8/2) dry; common coarse distinct yellowish brown (10YR 5/6) mottles; massive; friable; slightly acid.

The solum is 20 to 40 inches thick. It is medium acid or slightly acid. The mollic epipedon is 7 to 20 inches thick.

The A horizon has value of 2 or 3 (3 or 4 dry) and chroma of 1 or 2. The Bt horizon has hue of 10YR or 2.5Y, value of 3 to 5, and chroma of 2 or 3. It is dominantly silty clay loam, but the range includes silt loam. The C horizon has hue of 10YR to 5Y, value of 6 or 7, and chroma of 1 to 4. It is silt loam or very fine sandy loam.

Mayberry Series

The Mayberry series consists of deep, moderately well drained, slowly permeable soils on uplands. These soils formed in loamy and clayey, reworked glacial material. Slopes range from 3 to 9 percent.

Mayberry soils are similar to Pawnee soils and are commonly adjacent to Malcolm, Morrill, Pawnee, and Wymore soils. Pawnee soils are less red in the subsoil than the Mayberry soils. Malcolm soils formed in silty deposits and are commonly downslope from the Mayberry soils. Morrill soils have less clay in the subsoil than the Mayberry soils. They are in the same general position on the landscape as the Mayberry soils. Wymore soils formed in loess and are commonly upslope from the Mayberry soils.

Typical pedon of Mayberry clay loam, 3 to 9 percent slopes, 1,700 feet south and 225 feet east of the northwest corner of sec. 33, T. 4 N., R. 11 E.

A—0 to 12 inches; very dark brown (10YR 2/2) clay loam, dark gray (10YR 4/1) dry; moderate very fine and fine granular structure; friable, hard; medium acid; clear smooth boundary.

AB—12 to 16 inches; dark brown (7.5YR 3/2) clay loam, brown (7.5YR 4/2) dry; moderate fine subangular blocky structure; firm; slightly acid; clear smooth boundary.

Bt1—16 to 25 inches; reddish brown (5YR 4/4) clay, reddish brown (5YR 5/4) dry; common medium faint brown (7.5YR 4/2) mottles; moderate fine and medium angular blocky structure; very firm; slightly acid; clear smooth boundary.

Bt2—25 to 30 inches; mixed brown (7.5YR 5/2) and strong brown (7.5YR 4/6) clay, pinkish gray (7.5YR 6/2) and reddish yellow (7.5YR 6/6) dry; moderate medium angular blocky structure; very firm; neutral; clear smooth boundary.

Bt3—30 to 38 inches; brown (10YR 5/3) clay, pale brown (10YR 6/3) dry; few fine faint dark yellowish brown (10YR 4/4) mottles; moderate medium angular blocky structure; very firm; neutral; gradual smooth boundary.

BC—38 to 56 inches; brown (10YR 5/3) clay, very pale brown (10YR 7/3) dry; few fine faint light brownish gray (10YR 6/2) and dark yellowish brown (10YR 4/4) mottles; weak medium angular blocky structure; firm; few calcium carbonate concretions; moderately alkaline; gradual smooth boundary.

C—56 to 75 inches; mixed pale brown (10YR 6/3) and reddish brown (5YR 4/4) clay loam, very pale brown (10YR 7/3) and yellowish red (5YR 5/6) dry; massive; friable; moderately alkaline.

The solum is 40 to 70 inches thick. The mollic epipedon is 10 to 21 inches thick. Pebbles cover more than 3 percent of the surface and make up more than 3 percent of the profile. They make up as much as 15 percent of stone lines in the profile.

The A horizon has value of 2 or 3 (4 or 5 dry) and chroma of 1 or 2. It is dominantly clay loam, but the range includes loam, silty clay loam, and clay. This horizon is slightly acid or medium acid. The upper part of the Bt horizon has hue of 7.5YR or 5YR, value of 3 to 5 (4 to 6 dry), and chroma of 2 to 4. The lower part has hue of 10YR, value of 4 or 5 (5 or 6 dry), and chroma of 2 to 6. The Bt horizon is medium acid to neutral. In some pedons, the lower part of the B horizon has bands of dissimilar material, some with a considerable amount of silt and others with a considerable amount of sand.

Mayberry clay, 3 to 9 percent slopes, eroded, is a taxadjunct to the series because it does not have a mollic epipedon. This difference, however, does not alter the usefulness or behavior of the soil.

Morrill Series

The Morrill series consists of deep, well drained, moderately permeable soils on uplands. These soils formed in loamy, reworked glacial material (fig. 14). Slopes range from 5 to 11 percent.

Morrill soils are similar to Shelby soils and are commonly adjacent to Dickinson, Malcolm, Mayberry, and Wymore soils. Shelby soils are less red in the subsoil than the Morrill soils. Dickinson soils formed in sandy material, and Malcolm soils formed in silty deposits. Dickinson soils are in the same general position on the landscape as the Morrill soils, and Malcolm soils commonly are downslope from the Morrill soils. Mayberry soils have more clay in the subsoil than

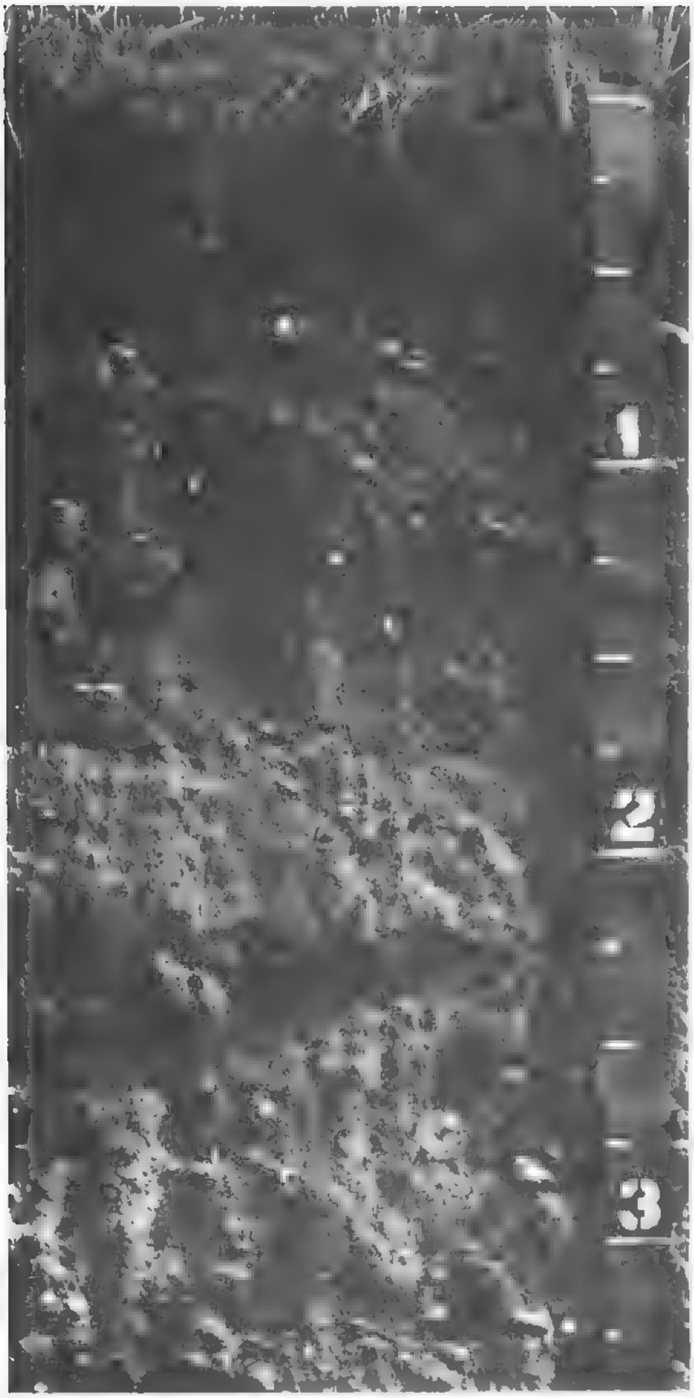


Figure 14.—Profile of Morrill clay loam. Depth is marked in feet.

the Morrill soils. They are in the same general position on the landscape as the Morrill soils. Wymore soils formed in loess and are commonly upslope from the Morrill soils.

Typical pedon of Morrill clay loam, 5 to 11 percent slopes, 150 feet east and 125 feet south of the northwest corner of sec. 13, T. 6 N., R. 11 E.

Ap—0 to 8 inches; very dark gray (10YR 3/1) clay loam, dark grayish brown (10YR 4/2) dry; weak fine crumb structure; friable, slightly hard; slightly acid; clear smooth boundary.

BA—8 to 12 inches; dark brown (7.5YR 3/2) clay loam, dark brown (10YR 4/3) dry; moderate fine subangular blocky structure; friable; slightly acid; clear smooth boundary.

Bt1—12 to 18 inches; dark reddish brown (5YR 3/3) clay loam, dark brown (7.5YR 4/4) dry; moderate fine and medium subangular blocky structure; friable; slightly acid; gradual smooth boundary.

Bt2—18 to 29 inches; dark reddish brown (5YR 3/4) clay loam, brown (7.5YR 5/4) dry; weak medium and fine subangular blocky structure; friable; common distinct clay films; slightly acid; gradual smooth boundary.

BC—29 to 48 inches; brown (7.5YR 4/4) sandy clay loam, brown (7.5YR 5/4) dry; weak medium angular blocky structure; friable; distinct and prominent clay films; sandy coatings on vertical faces of peds and in pores; slightly acid; gradual smooth boundary.

C—48 to 60 inches; strong brown (7.5YR 5/6) fine sandy loam, reddish yellow (7.5YR 6/6) dry; stone line 1 to 2 inches thick at top of horizon; massive; friable; slightly acid.

The solum is 30 to 60 inches thick. It is medium acid or slightly acid throughout. The mollic epipedon is 10 to 18 inches thick.

The A horizon has value of 2 or 3 (4 or 5 dry) and chroma of 1 to 3. It is dominantly clay loam, but the range includes loam, sandy loam, and gravelly sandy loam. The Bt horizon has hue of 7.5YR or 5YR, value of 3 or 4 (4 or 5 dry), and chroma of 3 to 6. It is clay loam, sandy clay loam, or gravelly clay loam. The C horizon has hue of 10YR to 5YR, value of 4 or 5 (5 or 6 dry), and chroma of 3 to 6. It is clay loam, loam, sandy loam, sandy clay loam, gravelly loam, or gravelly sandy loam.

Morrill clay loam, 5 to 11 percent slopes, eroded, is a taxadjunct to the series because it does not have a mollic epipedon. This difference, however, does not alter the usefulness or behavior of the soil.

Nishna Series

The Nishna series consists of deep, poorly drained, slowly permeable soils on bottom lands. These soils formed in calcareous, clayey alluvium. Slopes are 0 to 1 percent.

Nishna soils are similar to Zook soils and are commonly adjacent to Zoe and Zook soils. Zook soils are more acid than the Nishna soils and do not have free carbonates. Zoe soils are saline-alkaline and are

higher in content of exchangeable sodium than the Nishna soils. They are in positions on the landscape similar to those of the Nishna soils.

Typical pedon of Nishna silty clay, 0 to 1 percent slopes, 1,200 feet north and 150 feet east of the southwest corner of sec. 1, T. 6 N., R. 11 E.

A1—0 to 4 inches; very dark gray (10YR 3/1) silty clay, dark gray (10YR 4/1) dry; weak fine granular structure; firm, very hard; mildly alkaline; clear smooth boundary.

A2—4 to 15 inches; black (2.5Y 2/1) silty clay, very dark gray (10YR 3/1) dry; moderate fine granular structure; firm; strong effervescence; moderately alkaline; gradual smooth boundary.

A3—15 to 36 inches; black (2.5Y 2/1) silty clay, dark gray (2.5Y 4/1) dry; moderate fine and very fine subangular blocky structure; firm; strong effervescence; moderately alkaline; gradual smooth boundary.

Bg—36 to 48 inches; very dark gray (10YR 3/1) silty clay, dark gray (10YR 4/1) dry; moderate fine and very fine angular blocky structure; very firm; few fine calcium carbonate concretions; strong effervescence; moderately alkaline; gradual smooth boundary.

Cg1—48 to 60 inches; very dark gray (2.5Y 3/1) silty clay, dark gray (10YR 4/1) dry; massive; very firm; many fine calcium carbonate concretions; strong effervescence; moderately alkaline; gradual smooth boundary.

Cg2—60 to 70 inches; dark gray (2.5Y 4/1) silty clay, gray (2.5Y 5/1) dry; few medium faint olive brown (2.5Y 3/4) mottles; massive; very firm; many fine calcium carbonate concretions; strong effervescence; moderately alkaline.

The solum is 30 to 50 inches thick. It has a clay content of 38 to 45 percent. The depth to free carbonates is less than 10 inches.

The A horizon has hue of 10YR or 2.5Y or is neutral in hue. It has value of 2 or 3 (3 or 4 dry) and chroma of 0 to 2. It is mildly alkaline or moderately alkaline. In some pedons the plow layer is neutral. The Bg horizon has hue of 10YR, 2.5Y, or 5Y or is neutral in hue. It has value of 2 to 4 (3 to 5 dry) and chroma of 0 to 2. The Cg horizon has hue of 10YR or 2.5Y or is neutral in hue. It has value of 3 or 4 (4 to 6 dry) and chroma of 0 to 2.

Nodaway Series

The Nodaway series consists of deep, moderately well drained, moderately permeable soils on bottom lands. These soils formed in recent, stratified, silty alluvium. Slopes range from 0 to 4 percent.

Nodaway soils are commonly adjacent to Kennebec and Zook soils. Kennebec soils are dark to a depth of more than 24 inches. They are in positions on the landscape similar to those of the Nodaway soils. Zook soils are poorly drained, have more clay than the Nodaway soils, and are lower on the landscape.

Typical pedon of Nodaway silt loam, 0 to 1 percent slopes, 1,500 feet west and 100 feet north of the southeast corner of sec. 2, T. 6 N., R. 9 E.

Ap—0 to 5 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak very fine and fine subangular blocky structure; friable, slightly hard; neutral; clear smooth boundary.

C—5 to 60 inches; stratified very dark grayish brown (10YR 3/2), dark gray (10YR 4/1), and dark grayish brown (10YR 4/2) silt loam, dark grayish brown (10YR 4/2) and light brownish gray (10YR 6/2) dry; massive; common fine and medium horizontal cleavage planes; friable; neutral.

The A horizon is 5 to 10 inches thick. It has value of 3 (4 or 5 dry) and chroma of 1 or 2. The C horizon has value of 3 to 5 (4 to 7 dry) and chroma of 1 to 3. It is dominantly silt loam, but in some pedons the fine strata are silty clay loam or very fine sandy loam.

Pawnee Series

The Pawnee series consists of deep, moderately well drained, slowly permeable soils on uplands. These soils formed in glacial till (fig. 15). Slopes range from 3 to 12 percent.

Pawnee soils are similar to Mayberry soils and are commonly adjacent to Burchard, Mayberry, Shelby, and Wymore soils. Mayberry soils have a reddish subsoil. Burchard and Shelby soils have less clay in the subsoil than the Pawnee soils. Also, they are commonly lower on the landscape. Wymore soils formed in loess and are generally upslope from the Pawnee soils.

Typical pedon of Pawnee clay loam, 3 to 9 percent slopes, 775 feet south and 350 feet west of the northeast corner of sec. 20, T. 4 N., R. 9 E.

A—0 to 12 inches; very dark brown (10YR 2/2) clay loam, dark gray (10YR 4/1) dry; moderate very fine and fine granular structure; friable, hard; medium acid; clear smooth boundary.

BA—12 to 17 inches; very dark grayish brown (10YR 3/2) clay, grayish brown (10YR 5/2) dry; moderate fine subangular blocky structure; firm; slightly acid; clear smooth boundary.

Bt1—17 to 27 inches; dark grayish brown (10YR 4/2) clay, light brownish gray (10YR 6/2) dry; common medium faint dark yellowish brown (10YR 4/4) mottles; moderate fine and medium angular blocky structure; very firm; common fine round dark accumulations; neutral; gradual smooth boundary.

Bt2—27 to 36 inches; grayish brown (2.5Y 5/2) clay, light brownish gray (2.5Y 6/2) dry; many medium

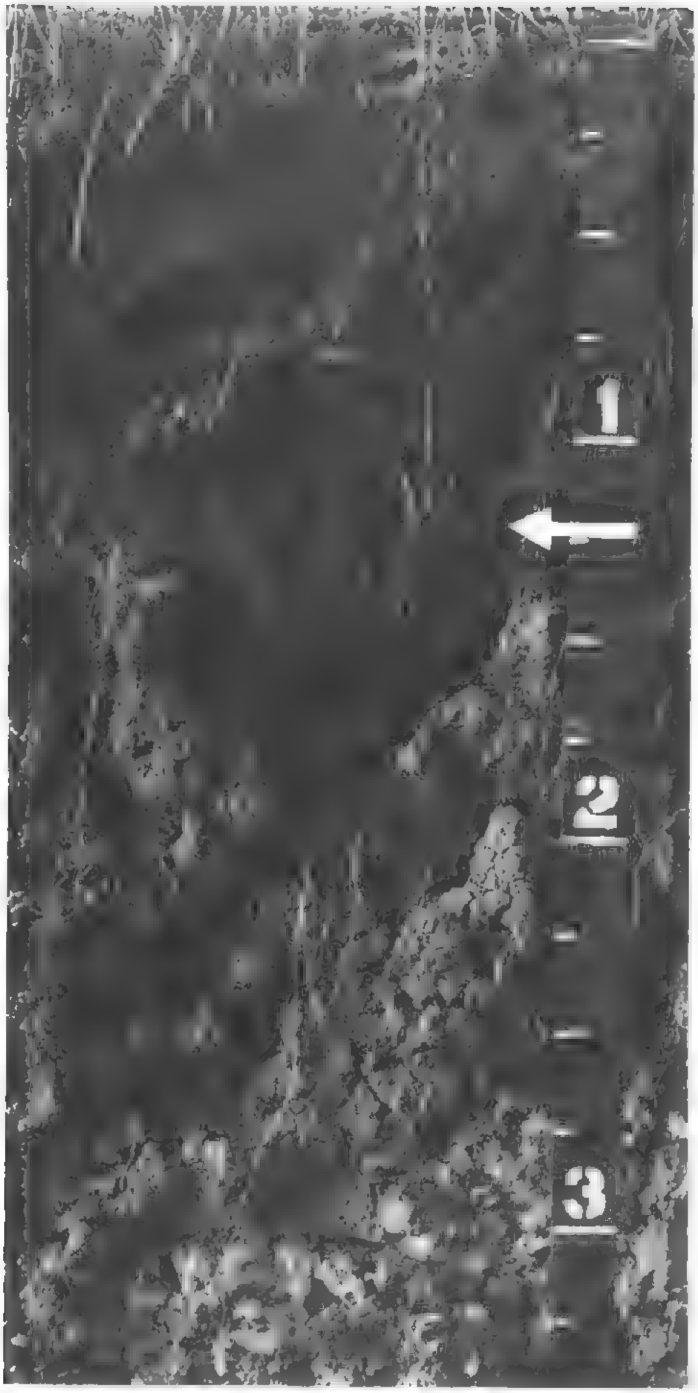


Figure 15.—Profile of Pawnee clay loam. The arrow indicates the top of the argillic horizon. Depth is marked in feet.

distinct dark yellowish brown (10YR 4/4) mottles; moderate medium angular blocky structure; very firm; few fine round dark accumulations; mildly alkaline; gradual smooth boundary.

Bt3—36 to 42 inches; grayish brown (2.5Y 5/2) clay, light brownish gray (2.5Y 6/2) dry; few fine distinct dark yellowish brown (10YR 4/4) mottles; weak medium angular blocky structure; firm; few fine round dark accumulations; few fine calcium carbonate concretions; moderately alkaline; clear smooth boundary.

BC—42 to 57 inches; mottled light brownish gray (2.5Y 6/2) and yellowish brown (10YR 5/6) clay loam; weak medium and coarse angular blocky structure; firm; calcium carbonate coatings on faces of peds; moderately alkaline; gradual smooth boundary.

C—57 to 70 inches; mottled light brownish gray (2.5Y 6/2) and dark yellowish brown (10YR 4/6) clay loam; massive; common angular cleavage planes; firm; few large pockets or accumulations of calcium carbonate; strong effervescence; moderately alkaline.

The solum is 40 to 60 inches thick. The mollic epipedon is 10 to 19 inches thick. Pebbles and cobblestones cover 0 to 5 percent of the surface and make up 0 to 5 percent of the profile. Pebbles make up as much as 15 percent of the stone lines in the profile.

The A horizon has value of 2 or 3 (4 or 5 dry) and chroma of 1 or 2. It is dominantly clay loam, but the range includes silt loam, silty clay loam, loam, and clay. This horizon is medium acid or slightly acid. The Bt horizon has value of 3 to 5 (4 to 6 dry) and chroma of 2 to 4. Value generally increases with increasing depth. This horizon is slightly acid or neutral. The C horizon has hue of 10YR to 5Y, value of 5 or 6 (6 or 7 dry), and chroma of 2 or 3. It has mottles with value and chroma of 4 to 6. It is dominantly clay loam, but part of the till mass has strata of loam or clay. This horizon is mildly alkaline or moderately alkaline.

The eroded Pawnee soils do not have a mollic epipedon and have a solum that is thinner than is definitive for the series. These differences, however, do not alter the usefulness or behavior of the soils.

Sharpsburg Series

The Sharpsburg series consists of deep, moderately well drained, moderately slowly permeable soils on uplands. These soils formed in loess. Slopes range from 1 to 4 percent.

Sharpsburg soils are commonly adjacent to Wymore soils. The adjacent soils have more clay in the Bt horizon than the Sharpsburg soils. They are in the same general landscape position as the Sharpsburg soils.

Typical pedon of Sharpsburg silty clay loam, 1 to 4 percent slopes, 175 feet south and 325 feet east of the northwest corner of sec. 8, T. 6 N., R. 12 E.

Ap—0 to 6 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry;

weak very fine granular structure; friable, hard; medium acid; clear smooth boundary.

A—6 to 11 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; friable; medium acid; clear smooth boundary.

BA—11 to 19 inches; dark brown (10YR 3/3) silty clay loam, dark grayish brown (10YR 4/2) dry; strong very fine subangular blocky structure; firm; medium acid; gradual smooth boundary.

Bt—19 to 36 inches; dark brown (10YR 4/3) silty clay loam, yellowish brown (10YR 5/4) dry; strong fine subangular blocky structure; firm; medium acid; gradual smooth boundary.

BC—36 to 57 inches; yellowish brown (10YR 5/4) silty clay loam, light yellowish brown (10YR 6/4) dry; faces of peds dark brown (10YR 4/3) and pale brown (10YR 6/3) dry; few fine faint dark yellowish brown (10YR 4/6) mottles; weak medium and coarse angular blocky structure; friable; slightly acid; gradual smooth boundary.

C—57 to 70 inches; yellowish brown (10YR 5/4) silty clay loam, pale brown (10YR 6/3) dry; common medium distinct grayish brown (10YR 5/2) mottles; massive; friable; slightly acid.

The solum is 40 to 60 inches thick. The mollic epipedon is 10 to 20 inches thick.

The A horizon has value of 2 or 3 (3 or 4 dry) and chroma of 1 to 3. The Bt horizon has value of 4 or 5 and chroma of 3 or 4. It has a clay content of 36 to 42 percent. The BC and C horizons have value of 4 to 6 and chroma of 2 to 4.

Shelby Series

The Shelby series consists of deep, well drained, moderately slowly permeable soils on uplands. These soils formed in loamy, calcareous glacial till (fig. 16). Slopes range from 9 to 30 percent.

Shelby soils are similar to Burchard and Morrill soils and are commonly adjacent to Burchard, Dickinson, Pawnee, and Steinauer soils. Burchard soils have carbonates within a depth of 30 inches. Morrill soils have a dark reddish brown subsoil. Dickinson soils formed in sandy material. They are in the same general landscape positions as the Shelby soils. Pawnee soils have more clay in the subsoil than the Shelby soils. Also, they are higher on the landscape. Steinauer soils do not have an argillic horizon and have carbonates at the surface. They are in positions on the landscape similar to those of the Shelby soils.

Typical pedon of Shelby clay loam, 9 to 15 percent slopes, 1,800 feet south and 75 feet east of the northwest corner of sec. 17, T. 5 N., R. 10 E.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) clay loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; friable, hard; 5 percent of surface covered with cobbles and pebbles; slightly acid; clear smooth boundary.

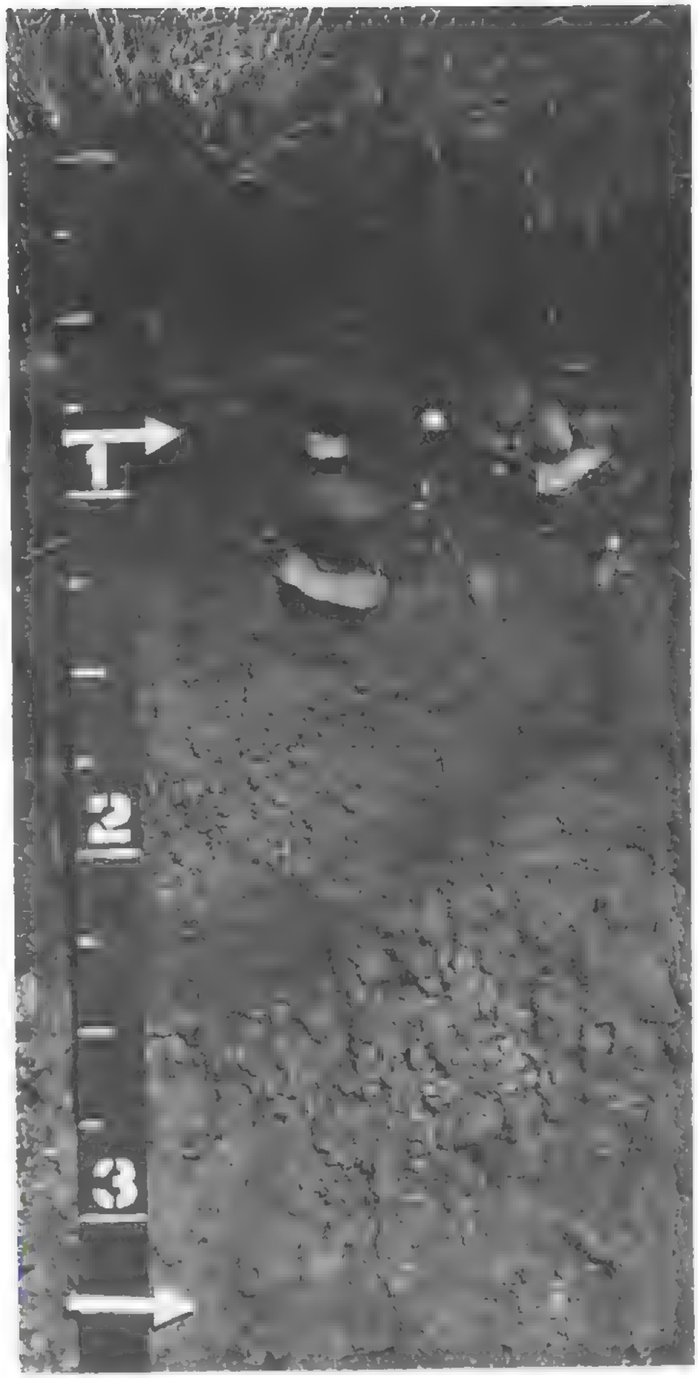


Figure 16.—Profile of Shelby clay loam. The upper arrow indicates a stone line, and the lower arrow indicates the depth to calcium carbonates. Depth is marked in feet.

A—8 to 15 inches; very dark gray (10YR 3/1) clay loam, very dark grayish brown (10YR 3/2) dry; weak medium subangular blocky structure parting to moderate fine granular; friable; medium acid; clear smooth boundary.

BA—15 to 21 inches; mixed very dark grayish brown (10YR 3/2) and dark yellowish brown (10YR 4/4) clay loam, dark grayish brown (10YR 4/2) and yellowish brown (10YR 5/4) dry; moderate fine subangular blocky structure; friable; 5 percent gravel; medium acid; clear smooth boundary.

Bt1—21 to 32 inches; mixed dark yellowish brown (10YR 4/4) and very dark grayish brown (10YR 3/2) clay loam, yellowish brown (10YR 5/4) and dark grayish brown (10YR 4/2) dry; moderate fine subangular blocky structure; firm; medium acid; clear smooth boundary.

Bt2—32 to 41 inches; yellowish brown (10YR 5/4) clay loam, light yellowish brown (10YR 6/4) dry; common fine distinct strong brown (7.5YR 4/6) mottles; moderate medium subangular blocky structure; firm; slightly acid; clear smooth boundary.

BC—41 to 51 inches; mottled pale brown (10YR 6/3) and strong brown (7.5YR 4/6) clay loam, very pale brown (10YR 8/3) and reddish yellow (7.5YR 6/6) dry; weak medium angular blocky structure; firm; few calcium carbonate concretions; slight effervescence; moderately alkaline; gradual smooth boundary.

C—51 to 70 inches; mixed light brownish gray (10YR 6/2), yellowish brown (10YR 5/6), and strong brown (7.5YR 4/6) clay loam, light gray (2.5Y 7/1), very pale brown (10YR 7/2), and reddish yellow (7.5YR 6/6) dry; massive; firm; many calcium carbonate concretions and pockets of soft lime; strong effervescence; moderately alkaline.

The solum is about 30 to 60 inches thick. The mollic epipedon is 10 to 24 inches thick. The depth to free carbonates is more than 30 inches. Pebbles and cobblestones cover 1 to 10 percent of the surface and make up 1 to 10 percent of the profile. Stone lines are in some pedons.

The A horizon has value of 2 or 3 (3 to 5 dry) and chroma of 1 or 2. It is dominantly clay loam, but the range includes loam. This horizon is medium acid to neutral. The Bt horizon also is medium acid to neutral. It has value of 3 to 5 (4 to 6 dry) and chroma of 3 to 6. The C horizon is clay loam or loam. It is neutral to moderately alkaline.

Steinauer Series

The Steinauer series consists of deep, well drained and somewhat excessively drained, moderately slowly permeable soils on uplands. These soils formed in loamy, calcareous glacial till (fig. 17). Slopes range from 9 to 20 percent.

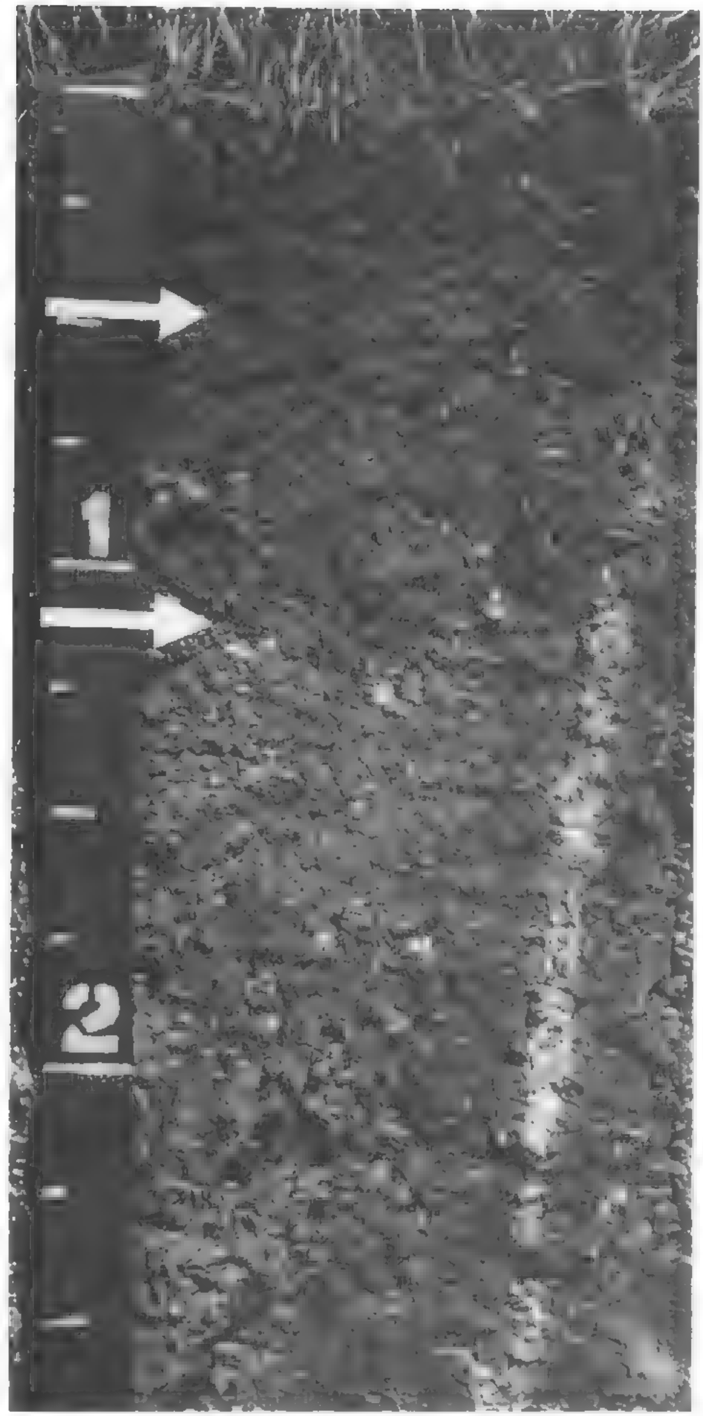


Figure 17.—Profile of Steinauer clay loam. The upper arrow indicates the base of the A horizon, and the lower arrow indicates the base of the AC horizon. The white streak on the right side of the profile is an accumulation of carbonates. Depth is marked in feet.

Steinauer soils are commonly adjacent to Burchard, Pawnee, and Shelby soils. The adjacent soils have an argillic horizon. Also, they have carbonates below the surface layer. Burchard and Shelby soils are commonly in positions on the landscape similar to those of the Steinauer soils. Pawnee soils are mainly upslope from the Steinauer soils.

Typical pedon of Steinauer clay loam, 15 to 20 percent slopes, 780 feet north and 150 feet west of the southeast corner of sec. 4, T. 4 N., R. 9 E.

A—0 to 6 inches; very dark grayish brown (10YR 3/2) clay loam, grayish brown (10YR 5/2) dry; moderate very fine and fine granular structure; friable, hard; 5 to 10 percent gravel; violent effervescence; moderately alkaline; clear smooth boundary.

AC—6 to 17 inches; brown (10YR 5/3) clay loam, pale brown (10YR 6/3) dry; moderate very fine and fine subangular blocky structure; friable; 2 to 5 percent gravel; few concretions of calcium carbonates in the lower part; violent effervescence; moderately alkaline; gradual smooth boundary.

C—17 to 60 inches; mixed light brownish gray (2.5Y 6/2), light olive brown (2.5Y 5/4), and yellowish brown (10YR 5/6) clay loam, light gray (2.5Y 7/2), light yellowish brown (2.5Y 6/4), and brownish yellow (10YR 6/6) dry; massive; common medium angular cleavage planes; firm; 2 to 5 percent gravel; few concretions of calcium carbonates; violent effervescence; moderately alkaline.

The solum is 10 to 21 inches thick. The depth to free carbonates ranges from 0 to about 6 inches. Pebbles and cobblestones cover 2 to 10 percent of the surface and make up 2 to 10 percent of the profile.

The A horizon has hue of 10YR or 2.5Y, value of 3 to 5 (5 or 6 dry), and chroma of 1 or 2. It is dominantly clay loam, but the range includes loam. This horizon is mildly alkaline or moderately alkaline. The AC horizon has hue of 10YR or 2.5Y, value of 4 or 5 (5 or 6 dry), and chroma of 1 to 4. The C horizon is dominantly clay loam, but the range includes loam. The calcium carbonate equivalent in this horizon ranges from 5 to 15 percent.

Wabash Series

The Wabash series consists of deep, very poorly drained, very slowly permeable soils on bottom lands. These soils formed in clayey alluvium. Slopes are 0 to 1 percent. They are generally less than 0.5 percent.

Wabash soils are commonly adjacent to Zoe and Zook soils. Zoe soils have soluble salts and are high in content of exchangeable sodium. Zook soils have less clay throughout than the Wabash soils. Also, they are higher on the landscape.

Typical pedon of Wabash silty clay, 0 to 1 percent slopes, 2,185 feet south and 150 feet west of the northeast corner of sec. 22, T. 5 N., R. 10 E.

A1—0 to 8 inches; very dark gray (10YR 3/1) silty clay, dark gray (10YR 4/1) dry; weak medium and fine subangular blocky structure; firm, very hard; neutral; clear smooth boundary.

A2—8 to 20 inches; black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; moderate fine subangular blocky structure; very firm; shiny pressure faces on peds; neutral; clear smooth boundary.

Bg1—20 to 40 inches; black (N 2/0) silty clay, very dark gray (N 3/0) dry; moderate medium and fine subangular blocky structure; very firm; shiny faces on peds; neutral; gradual smooth boundary.

Bg2—40 to 60 inches; black (N 2/0) silty clay; moderate medium and fine subangular blocky structure; very firm; few fine lime concretions; mildly alkaline.

The thickness of the solum and the depth to carbonates range from 40 to more than 60 inches. The A horizon has hue of 2.5Y or 10YR or is neutral in hue. It has value of 2 or 3 (3 or 4 dry) and chroma of 0 to 2. It is neutral to medium acid. The part of the Bg horizon within a depth of 36 inches has the same range in color and reaction as the A horizon. The part below a depth of 36 inches has similar colors, but value can be 4 or 5 (5 or 6 dry). Reaction is slightly acid to mildly alkaline below a depth of 36 inches.

Wymore Series

The Wymore series consists of deep, moderately well drained, slowly permeable soils on uplands. These soils formed in loess. Slopes range from 0 to 7 percent.

Wymore soils are commonly adjacent to Mayberry, Pawnee, and Sharpsburg soils. Mayberry and Pawnee soils formed in glacial till. They are downslope from the Wymore soils. Sharpsburg soils have less clay in the B horizon than the Wymore soils. They are in the same general landscape position as the Wymore soils.

Typical pedon of Wymore silty clay loam, 0 to 2 percent slopes, 1,350 feet east and 100 feet south of the northwest corner of sec. 20, T. 5 N., R. 12 E.

Ap—0 to 10 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; weak fine and medium subangular blocky structure; friable, hard; slightly acid; clear smooth boundary.

Bt1—10 to 19 inches; very dark grayish brown (10YR 3/2) silty clay, dark grayish brown (10YR 4/2) dry; strong fine and very fine subangular blocky structure; firm; medium acid; clear smooth boundary.

Bt2—19 to 33 inches; dark grayish brown (10YR 4/2) silty clay, grayish brown (10YR 5/2) dry; few fine distinct dark yellowish brown (10YR 4/4) mottles; strong medium and fine angular blocky structure; firm; neutral; gradual smooth boundary.

Bt3—33 to 41 inches; dark grayish brown (2.5Y 4/2) silty clay, light brownish gray (2.5Y 6/2) dry; common

medium distinct dark yellowish brown (10YR 4/4) mottles; moderate medium and fine angular blocky structure; firm; neutral; gradual smooth boundary.

BC—41 to 50 inches; grayish brown (2.5Y 5/2) silty clay loam, light brownish gray (2.5Y 6/2) dry; many medium distinct dark yellowish brown (10YR 4/4) mottles; weak medium angular blocky structure; firm; neutral; gradual smooth boundary.

C—50 to 70 inches; light brownish gray (2.5Y 6/2) silty clay loam, light gray (2.5Y 7/2) dry; many coarse distinct dark yellowish brown (10YR 4/4) mottles; massive; friable; few carbonate concretions; common pores; neutral.

The solum typically is 40 inches thick, but ranges from 33 to 50 inches. The mollic epipedon is 10 to 20 inches thick.

The A horizon has value of 2 or 3 (3 or 4 dry) and chroma of 1 or 2. It is medium acid or slightly acid. The Bt horizon has hue of 10YR or 2.5Y, value of 3 to 5 (4 to 6 dry), and chroma of 2. The BC and C horizons have hue of 10YR, 2.5Y, or 5Y, value of 5 or 6 (6 or 7 dry), and chroma of 1 or 2. They are faintly to prominently mottled, and in some pedons the matrix color is masked by the color of high chroma mottles.

Wymore silty clay, 2 to 7 percent slopes, eroded, does not have a mollic epipedon and has a solum that is thinner than is definitive for the series (fig. 18). These differences, however, do not alter the usefulness or behavior of the soil.

Zoe Series

The Zoe series consists of deep, poorly drained, slowly permeable, saline-alkaline soils on bottom lands. These soils formed in alluvium. Slopes are 0 to 1 percent.

Zoe soils are commonly adjacent to Nishna, Wabash, and Zook soils. The adjacent soils have a lower content of soluble salts and exchangeable sodium than the Zoe soils. They are in the same general landscape positions as the Zoe soils. Wabash soils are very poorly drained.

Typical pedon of Zoe silty clay loam, in an area of Zoe-Zook silty clay loams, 0 to 1 percent slopes, 1,675 feet north and 325 feet west of the southeast corner of sec. 22, T. 5 N., R. 10 E.

A—0 to 12 inches; very dark gray (10YR 3/1) silty clay loam, gray (10YR 5/1) dry; moderate very fine and fine subangular blocky structure; friable, hard; neutral; gradual smooth boundary.

Az1—12 to 22 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; moderate fine subangular blocky structure; friable; common white accumulations of salts on faces of peds; common roots; mildly alkaline; gradual smooth boundary.

Az2—22 to 32 inches; very dark gray (10YR 3/1) silty clay, dark gray (10YR 4/1) dry; moderate fine and medium subangular blocky structure; firm; common grayish accumulations of salts on faces of peds; few roots; mildly alkaline; gradual smooth boundary.

AC—32 to 42 inches; very dark gray (10YR 3/1) silty clay, gray (10YR 5/1) dry; weak medium angular blocky structure; very firm; few fine calcium

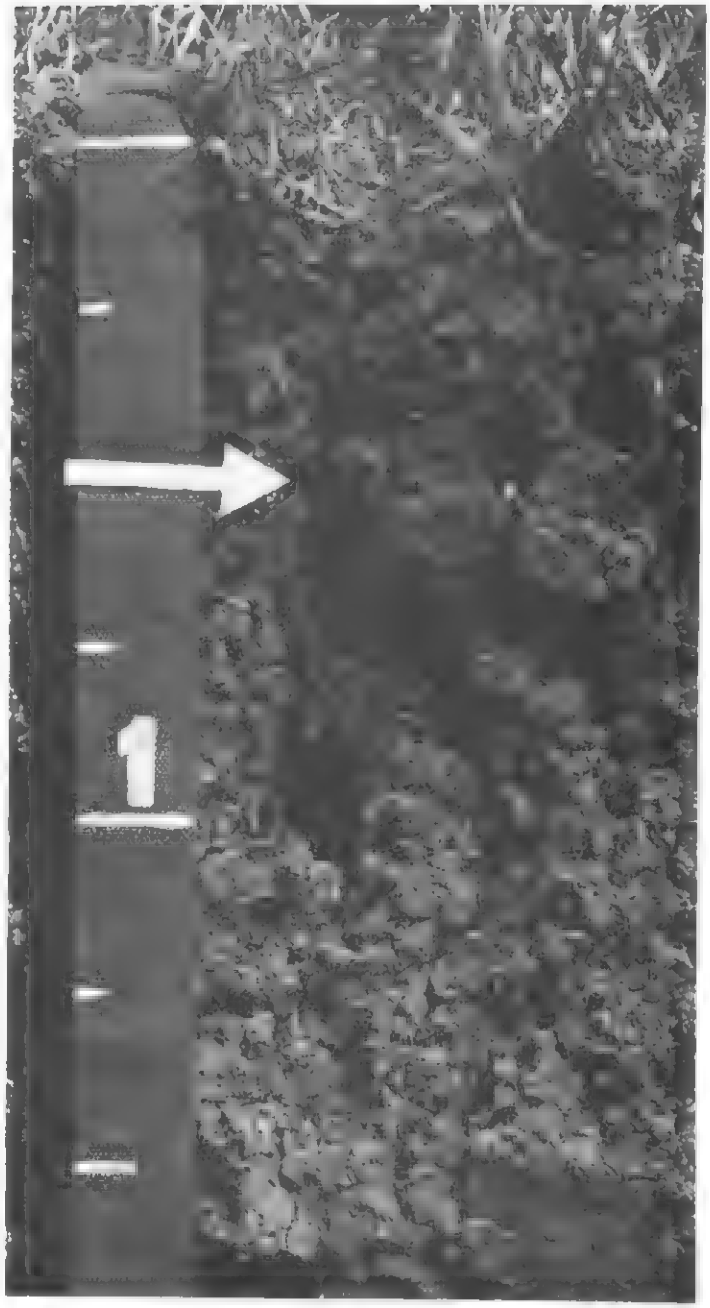


Figure 18.—Profile of Wymore silty clay, 2 to 7 percent slopes, eroded. The arrow indicates the lower part of the A horizon. Depth is marked in feet.

carbonate concretions; strong effervescence; moderately alkaline; gradual smooth boundary.

C—42 to 60 inches; dark gray (10YR 4/1) silty clay, gray (10YR 6/1) dry; few fine distinct brown (10YR 4/3) mottles; massive; firm; many fine calcium carbonate concretions; violent effervescence; moderately alkaline; gradual smooth boundary.

The solum is 26 to 50 inches thick. Typically, no free carbonates are in the A horizon, but concretionary lime is in the AC or C horizon. The content of exchangeable sodium is 5 to 25 percent in the solum, and conductivity of the saturation extract ranges from 3 to 15 millimhos per centimeter.

The A horizon has hue of 10YR or 2.5Y or is neutral in hue. It has value of 2 or 3 (4 or 5 dry) and chroma dominantly of 0 to 2. It is silty clay loam or silty clay and is neutral or mildly alkaline. The AC and C horizons have hue of 10YR, 2.5Y, or 5Y or are neutral in hue. They have value of 3 to 5 (4 to 6 dry) and chroma of 0 to 2. They are silty clay or silty clay loam and are mildly alkaline or moderately alkaline.

Zook Series

The Zook series consists of deep, poorly drained, slowly permeable soils on bottom lands. These soils formed in silty and clayey alluvium. Slopes are 0 to 1 percent.

Zook soils are similar to Nishna soils and are commonly adjacent to Nishna, Nodaway, Wabash, and Zoe soils. Nishna soils have free carbonates. Nodaway soils are moderately well drained, have less clay than the Zook soils, and are higher on the landscape. Wabash and Zoe soils are in the same general landscape position as the Zook soils. Wabash soils have more clay in the upper part than the Zook soils, and Zoe soils have a higher content of soluble and alkaline salts.

Typical pedon of Zook silty clay loam, 0 to 1 percent slopes, 2,450 feet east and 125 feet south of the northwest corner of sec. 36, T. 4 N., R. 11 E.

Ap—0 to 8 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; weak medium and fine subangular blocky structure; friable, hard; slightly acid; clear smooth boundary.

A—8 to 22 inches; very dark gray (10YR 3/1) silty clay loam, gray (10YR 5/1) dry; weak medium angular blocky structure parting to weak fine subangular blocky; friable; common pores; medium acid; clear smooth boundary.

Bg—22 to 60 inches; very dark gray (10YR 3/1) silty clay, dark gray (10YR 4/1) dry; moderate medium angular blocky structure; firm; few fine distinct strong brown (7.5YR 5/6) mottles below a depth of 36 inches; neutral.

The solum is 36 to more than 60 inches thick. It is medium acid to mildly alkaline.

The A horizon has hue of 10YR or 2.5Y or is neutral in hue. It has value of 2 or 3 (4 or 5 dry) and chroma of 0 to 2. The silty clay loam in the upper part of the profile is 10 to 25 inches thick. Some pedons have an Ap horizon of silt loam. The Bg horizon has hue of 10YR to 5Y or is neutral in hue. It has value of 2 to 5 (3 to 6 dry) and chroma of 0 to 2. In some pedons, mottles of high value and chroma are below a depth of 36 inches.

Formation of the Soils

Soil forms through the interaction of five major factors: parent material, time, relief, plants and animals, and climate. The kind of soil that forms in any place is determined by the interaction of these factors.

Climate and plants and animals are the active factors of soil formation. They act on the parent material, which has accumulated through the weathering of rock and unconsolidated deposits, and slowly change it into a natural body that has genetically related horizons. The effects of climate and of plants and animals are conditioned by relief. Parent material also influences soil formation and, in extreme cases, largely determines the kind of soil that forms. Finally, time is needed for changing the parent material into a soil. In general, a long time is required for distinct horizons to develop in a soil.

The interrelationship among the five factors of soil formation is complex, and the effect of any one factor is difficult to isolate. Each factor is described separately in the following paragraphs; however, the interaction among all five factors, rather than just their simple sum, determines the nature of the soil.

Parent Material

Parent material is the unconsolidated mass or consolidated material in which a soil forms. It affects the chemical and mineralogical composition of the soil. The soils in Johnson County formed in recent alluvium, colluvium, loess, silty sediments, glacial material, and shale and limestone residuum. Alluvium is the youngest material, and the material weathered from of Pennsylvanian limestone and shale is the oldest.

Geologic erosion has stripped most of the ancient soils from the landscape and exposed fresh parent material. As a result, soils having parent material that is a million years old have been forming for about the same length of time as soils that formed in the most recent loess, which is less than 20,000 years old.

The oldest geologic materials in which the modern soils have formed are those weathered from Permian and Pennsylvanian limestone and shale. They were deposited in shallow seas 200 to 300 million years ago. They were buried under many feet of younger deposits, they have been reexposed on slopes bordering the valley of the North Fork of the Big Nemaha River. They consist of ledges of moderately hard limestone and beds of calcareous, silty shale. These materials weather to olive gray, olive, pale yellow, brown, or weak red silty material that has shale and limestone fragments. Benfield and Kipson soils formed in this material.

Material left by the Nebraskan glacier overlies the shale and limestone. It is clayey till that has many limestone pebbles, cobbles, and a small amount of quarzitic sand and stone. The acreage of soils formed in this material is small. Most of this material has been covered by younger sediment.

During the Fullerton age, after the retreat of the Nebraskan glacier, alluvial silt and very fine sand were deposited. These buried deposits are preserved in upland areas and are exposed intermittently at the lower elevations on rolling hillsides throughout the county. Malcolm soils formed in this grayish silt and very fine sand. In places, remnants of the ancient Afton soils, which formed in Fullerton material, can be identified by their alkali nature and clayey texture. Areas of such outcrops are thinly vegetated.

Kansan glacial material was the next deposit laid down in the county. Much of this material has been removed by geologic erosion, and in places, all of it has been eroded. In some areas, more recent material covers the glacial deposits, but on slopes that border stream valleys and in a large area of the county, the glacial material is at the surface. It is mixed clay, sand, and silt and has pebbles, cobbles, and a few granite or quartzite boulders. Typically, it is clay loam. The unoxidized and unweathered till is gray, but the till exposed in roadcuts and in the lower part of the soils is oxidized and weathered to grayish brown and has yellowish brown, strong brown, and dark brown iron stains and concretions. Cracks and seams are filled with soft, white lime. Burchard, Pawnee, Shelby, and Steinauer soils formed in this till. Dickinson soils formed in loamy and sandy material at the base of Kansan glacial material. These soils are lower on the landscape than the Burchard, Pawnee, Shelby, and Steinauer soils.

Most of the Kansan till was removed by erosion at the end of the Kansan Glaciation. The silt and clay were washed from the area, and the coarser gravel, stones, and boulders were left. Illinoian material was deposited on this surface.

Illinoian material was deposited throughout the county, but only in certain areas is it thick enough to be recognized. The material, which lies below Peoria loess and above glacial material, is exposed only on slopes. It

is generally at the middle and lower elevations throughout the county. The reddish brown Illinoian soils contrast sharply with the yellowish brown and grayish brown soils that formed in Peoria loess and in Kansan glacial material. Stone lines or gravel lag lines are common in this reworked material. Mayberry soils formed in the clayey part of this material, which has some sand, pebbles, and stones derived from glacial material. Morrill soils formed in the loamy part of this material, which has many sand grains and pebbles. Loveland loess, which is of late Illinoian age, occurs as thin layers and is not an extensive parent material. Small areas of soils that formed in this material are included with Mayberry and Morrill soils in mapping.

Peoria loess is the most recently deposited parent material. It is grayish brown to light olive gray silty material that was carried by wind. It was deposited throughout the county and remains in areas where geologic erosion has been least active. These areas are the divides, ridges, and slopes at the higher elevations throughout the county. Wymore soils, which are extensive, formed in this loess.

Alluvium consists of recent, grayish brown to black, silty and clayey sediments that washed from upland slopes onto flood plains and valleys. Kennebec, Nishna, Nodaway, Wabash, Zoe, and Zook soils formed in alluvium. Some of the low plains and valleys are flooded, and fresh deposits continue to accumulate.

Silty sediments are deposited on some foot slopes and the lower side slopes adjacent to steeper uplands. They are deep deposits of friable material. This material was recently deposited by the combined actions of gravity and moving water. Judson soils formed in these silty sediments.

Climate

Climate affects weathering and soil formation in several ways. The kind and amount of rainfall received, temperature, humidity, and the nature of the winds are climatic factors. Climate also affects soil formation through its influence on the type and variety of plant and animal life. In Johnson County, the climate is fairly uniform. As a result, local differences among the soils cannot be attributed to differences in climate.

During the last geologic period, many climatic cycles influenced the shape of the landscape and the deposition of parent material in the county. Cold, wet periods preceded the deposition of glacial material. In dry, windy periods, dust accumulated as deposits of loess. Stable periods of weathering and soil formation alternated with periods of dissection and erosion.

Since deposition, the parent materials in Johnson County have undergone marked changes in color, structure, and composition. These changes are usually caused by leaching, oxidation, and other weathering processes; the accumulation of organic matter; the concentration of colloids and clay in the subsoil; and the partial removal of lime from the surface layer and the upper part of the subsoil.

The content of free calcium carbonate in the parent material originally varied. Leaching has removed most of the carbonates, as well as the other soluble constituents, to a depth below the subsoil. Except for areas of a few eroded soils and areas of recent alluvium, most of the soils are medium acid or slightly acid in the surface layer and the upper part of the subsoil. Even though they are leached, the soils contain a high percentage of the basic elements of a fertile soil.

An example of the influence of climate on the present character of the soils in the county is the uniform chemical composition of soils that formed on similar terrain but in different parent material. This uniformity has been brought about by a moderately long period of weathering.

Plants and Animals

Plants and animals have had a pronounced effect on soil formation in Johnson County. Vegetation, which is partly determined by climate, is one of the most important factors in soil formation. Animals are important in the way they use and convert vegetation. Human activity has an important effect on some soil properties.

One of the most striking characteristics of the uneroded grassland soils in the county is a dark color, which is the result of large amounts of organic matter in the soil. Prior to settlement, prairies of bluestems dominated the landscape. The stems, leaves, and roots of the tall grasses were an abundant supply of organic material. As a result, a thick, granular, dark soil formed at the surface.

Grassland plants extract calcium and other minerals from the soil and parent material and return them to the surface when the stems and leaves decay. This process and the fibrous root systems of grassland plants favor the formation of soil structure and the movement of water and soil particles in the soil. Other processes involve chemical and physical action. The decay of organic material and other compounds produce acid in the mineral part of the soil. Physical action includes the shrinking and swelling of fine particles as the soil is alternately dry and moist.

Some organic matter is lost through oxidation when the soil is plowed because mixing the soil speeds the decay of organic material. On slopes not protected from rain, much of the original surface soil and the organic matter have been lost through erosion. Cultivated soils never regain their original high content of organic matter because of the high oxidation rate under present farming methods. If erosion is controlled and if crop residue from corn, sorghum, and small grain is returned to the soil, the content of organic matter remains at a moderate level.

Micro-organisms, ants, earthworms, and burrowing animals have a beneficial effect on the fertility, structure, and productivity of the soil. Micro-organisms convert nitrogen, phosphorus, and potassium into a form available to plants. Specific kinds of micro-organisms make available to plants many minor elements or trace minerals, for example, zinc, sulphur, magnesium, and calcium. Earthworms and small burrowing animals mix organic matter with mineral soil material. Through their burrowing, they aerate the soils and bring unleached parent material to the surface.

Human activities affect the formation of soils. Some of the effects of these activities are accelerated sheet and gully erosion, changes in the moisture regime through runoff, improved drainage, and the addition of plant nutrients and other soil amendments. In places, erosion has changed the texture of the surface layer. In some areas, human activities have drastically changed the kinds of living organisms in the soil.

Relief

Some differences among soils can be attributed to local variations in relief. Relief affects soil formation mainly through its effect on drainage and runoff. In this way, relief modifies the effects of climate. Runoff is more rapid in steep areas than in nearly level or gently sloping areas. Consequently, less water soaks into the soil in steep areas, and leaching slower, and more soil is lost through erosion. Soil horizons in these areas are not distinct, and the solum is thin.

The differing soil properties of Steinauer, Burchard, and Pawnee soils can be attributed to relief. These soils formed in the same kind of parent material. Steinauer soils are moderately steep. They are weakly developed, have a thin surface layer, and have lime at the surface. Burchard soils commonly are not so steep as the Steinauer soils, have a thicker surface layer, are leached of lime to a greater depth, and have a thin subsoil. Pawnee soils are gently sloping and strongly sloping. They are in the more stable positions in drainage basins. They have a well developed subsoil and are leached of lime to a greater depth than is typical in the Burchard or Steinauer soils.

The effects of the landscape position on the water table and runoff are also important. The amount of soil moisture affects the kind and amount of vegetation that can grow on the soil. The water table and runoff are the most likely sources of salts and alkali, which form alkaline spots and have influenced the formation of some soils, for example, Zoe soils.

Time

The properties of a soil commonly reflect the length of time that the soil has been affected by the soil-forming processes. If the parent material has been in place only a short time, then climate and plants and animals have not had long to act and the soils do not have well defined horizons. As an example, Nodaway soils formed in recent alluvium, some of which was deposited during the last few years. These soils do not have well defined horizons.

The time required for soil formation varies with the parent material and the climate. Leaching, for example, is rapid in sandy material and slow in clayey material. In sandy material, there are few weatherable minerals and chemical and physical activity is weak. By comparison, clayey material is rich in weatherable minerals and chemical and physical activity is strong. Generally, soil formation is optimal in medium textured parent material. Water moves through this material at a moderate rate, and there are weatherable minerals for chemical and physical activity.

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Glossary

ABC soil. A soil having an A, a B, and a C horizon.

AC soil. A soil having only an A and a C horizon. Commonly such soil formed in recent alluvium or on steep rocky slopes.

Aeration, soil. The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alkali (sodic) soil. A soil having so high a degree of alkalinity (pH 8.5 or higher), or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that plant growth is restricted.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	more than 12

Base saturation. The degree to which material having cation exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the total cation exchange capacity.

Bedding planes. Fine stratifications, less than 5 millimeters thick, in unconsolidated alluvial, eolian, lacustrine, or marine sediments.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bottom land. The normal flood plain of a stream, subject to flooding.

Boulders. Rock fragments larger than 2 feet (60 centimeters) in diameter.

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Capillary water. Water held as a film around soil particles and in tiny spaces between particles. Surface tension is the adhesive force that holds capillary water in the soil.

Chiseling. Tillage with an implement having one or more soil-penetrating points that shatter or loosen hard compacted layers to a depth below normal plow depth.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Claypan. A slowly permeable soil horizon that contains much more clay than the horizons above it. A claypan is commonly hard when dry and plastic or stiff when wet.

Climax vegetation. The stabilized plant community on a particular site. The plant cover reproduces itself and does not change so long as the environment remains the same.

Coarse fragments. If round, mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in diameter; if flat, mineral or rock particles (flagstone) 15 to 38 centimeters (6 to 15 inches) long.

Coarse textured soil. Sand or loamy sand

Cobblestone (or cobble). A rounded or partly rounded fragment of rock 3 to 10 inches (7.5 to 25 centimeters) in diameter.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the base of steep slopes.

Complex, soil. A map unit of two or more kinds of soil in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils are somewhat similar in all areas

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Conservation tillage. A tillage system that does not invert the soil and that leaves a protective amount of crop residue on the surface throughout the year.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Decreasers. The most heavily grazed climax range plants. Because they are the most palatable, they are the first to be destroyed by overgrazing.

Deferred grazing. Postponing grazing or resting grazing land for a prescribed period.

Depth, soil. The thickness of the soil over bedrock. In this survey area, the classes of soil depth are very shallow, 0 to 10 inches; shallow, 10 to 20 inches; moderately deep, 20 to 40 inches; and deep, more than 40 inches.

Depth to rock (in tables). Bedrock is too near the surface for the specified use.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Drainage, surface. Runoff, or surface flow of water, from an area.

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes the surface.

Excess fines (in tables). Excess silt and clay in the soil. The soil is not a source of gravel or sand for construction purposes.

Fallow. Cropland left idle in order to restore productivity through accumulation of moisture. Summer fallow is common in regions of limited rainfall where cereal grains are grown. The soil is tilled for at least one growing season for weed control and decomposition of plant residue.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the ovendry weight, after the gravitational, or free, water has drained away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity,* or *capillary capacity.*

Fine textured soil. Sandy clay, silty clay, and clay.

Flagstone. A thin fragment of sandstone, limestone, slate, shale, or (rarely) schist, 6 to 15 inches (15 to 38 centimeters) long.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Forb. Any herbaceous plant not a grass or a sedge.

Frost action (in tables). Freezing and thawing of soil moisture. Frost action can damage roads, buildings and other structures, and plant roots.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Glacial outwash (geology). Gravel, sand, and silt, commonly stratified, deposited by glacial meltwater.

Glacial till (geology). Unsorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Gleyed soil. Soil that formed under poor drainage, resulting in the reduction of iron and other elements in the profile and in gray colors and mottles.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.

Gravelly soil material. Material that is 15 to 50 percent, by volume, rounded or angular rock fragments, not prominently flattened, up to 3 inches (7.6 centimeters) in diameter.

Green manure crop (agronomy). A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

Ground water (geology). Water filling all the unblocked pores of underlying material below the water table.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an uppercase letter represents the major horizons. Numbers or lowercase letters that follow represent subdivisions of the major horizons. The major horizons are as follows:

O horizon.—An organic layer of fresh and decaying plant residue.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, any plowed or disturbed surface layer.

E horizon.—The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these.

B horizon.—The mineral horizon below an O, A, or E horizon. The B horizon is in part a layer of transition from the overlying horizon to the underlying C horizon. The B horizon also has distinctive characteristics, such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) granular, prismatic, or blocky structure; (3) redder or browner colors than those in the A horizon, or (4) a combination of these.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the overlying horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, an Arabic numeral, commonly a 2, precedes the letter C.

Cr horizon.—Soft, consolidated bedrock beneath the soil.

R layer.—Hard, consolidated bedrock beneath the soil. The bedrock commonly underlies a C horizon but can be directly below an A or a B horizon.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Illuviation. The movement of soil material from one horizon to another in the soil profile. Generally, material is removed from an upper horizon and deposited in a lower horizon.

Increasers. Species in the climax vegetation that increase in amount as the more desirable plants are reduced by close grazing. Increasers commonly are the shorter plants and the less palatable to livestock.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Intake rate. The average rate of water entering the soil under irrigation. Most soils have a fast initial rate; the rate decreases with application time. Therefore, intake rate for design purposes is not a constant but is a variable depending on the net irrigation application. The rate of water intake in inches per hour is expressed as follows:

Less than 0.2	very low
0.2 to 0.4	low
0.4 to 0.75	moderately low
0.75 to 1.25	moderate
1.25 to 1.75	moderately high
1.75 to 2.5	high
More than 2.5	very high

Invaders. On range, plants that encroach into an area and grow after the climax vegetation has been reduced by grazing. Generally, invader plants follow disturbance of the surface.

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are—

Border.—Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.

Basin.—Water is applied rapidly to nearly level plains surrounded by levees or dikes.

Controlled flooding.—Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.

Corrugation.—Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.

Drip (or trickle).—Water is applied slowly and under low pressure to the surface of the soil or into the soil through such applicators as emitters, porous tubing, or perforated pipe.

Furrow.—Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.

Sprinkler.—Water is sprayed over the soil surface through pipes or nozzles from a pressure system.

Subirrigation.—Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.

Wild flooding.—Water, released at high points, is allowed to flow onto an area without controlled distribution.

Large stones (in tables). Rock fragments 3 inches (7.6 centimeters) or more across. Large stones adversely affect the specified use of the soil.

Leaching. The removal of soluble material from soil or other material by percolating water.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Low strength. The soil is not strong enough to support loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Moderately coarse textured soil. Coarse sandy loam, sandy loam, and fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, and silty clay loam.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Munsell notation. A designation of color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

Nutrient, plant. Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.

Organic matter. The organic fraction of the soil. It includes plant and animal residue at various stages of decomposition, cells and tissues of soil organisms, and substances synthesized by the soil population. It is commonly identified as the organic material that accompanies the soil material when a soil sample is put through a 2-millimeter sieve. In this survey area, the classes of organic matter content are high, 4.0 to 8.0 percent; moderate, 2.0 to 4.0 percent; moderately low, 1.0 to 2.0 percent; low, 0.5 to 1.0 percent.

Parent material. The unconsolidated organic and mineral material in which soil forms.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The downward movement of water through the soil.

Percs slowly (in tables). The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.2 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on features that affect its use and management. For example, slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Plowpan. A compacted layer formed in the soil directly below the plowed layer.

Ponding. Standing water on soils in closed depressions. Unless the soils are artificially drained, the water can be removed only by percolation or evapotranspiration.

Poor filter (in tables). Because of rapid permeability the soil may not adequately filter effluent from a waste disposal system.

Productivity, soil. The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Proper grazing use. The removal of not more than 50 percent, by weight, of the key management plants when an area of range or pasture is grazed. Proper grazing use protects the surface by maintaining an adequate plant cover. It also maintains or improves the quality and quantity of desirable vegetation.

Rangeland. Land on which the potential natural vegetation is predominantly grasses, grasslike plants, forbs, or shrubs suitable for grazing or browsing. It includes natural grasslands, savannas, many wetlands, some deserts, tundras, and areas that support certain forb and shrub communities.

Range condition. The present composition of the plant community on a range site in relation to the potential natural plant community for that site. Range condition is expressed as excellent, good, fair, or poor, on the basis of how much the present plant community has departed from the potential.

Range site. An area of rangeland where climate, soil, and relief are sufficiently uniform to produce a distinct natural plant community. A range site is the product of all the environmental factors responsible for its development. It is typified by an association of species that differ from those on other range sites in kind or proportion of species or total production.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH
Extremely acid	below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Residuum (residual soil material). Unconsolidated, weathered, or partly weathered mineral material that accumulated as consolidated rock disintegrated in place

Rill. A steep sided channel resulting from accelerated erosion. A rill is generally a few inches deep and not wide enough to be an obstacle to farm machinery.

Rippable. Bedrock or hardpan can be excavated using a single-tooth ripping attachment mounted on a tractor with a 200-300 draw bar horsepower rating.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Saline soil. A soil containing soluble salts in an amount that impairs growth of plants. A saline soil does not contain excess exchangeable sodium.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sedimentary rock. Rock made up of particles deposited from suspension in water. The chief kinds of sedimentary rock are conglomerate, formed from gravel; sandstone, formed from sand; shale, formed from clay; and limestone, formed from soft masses of calcium carbonate. There are many intermediate types. Some wind-deposited sand is consolidated into sandstone.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the underlying material. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Shale. Sedimentary rock formed by the hardening of a clay deposit.

Sheet erosion. The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and surface runoff.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Similar soils. Soils that share limits of diagnostic criteria, behave and perform in a similar manner, and have similar conservation needs or management requirements for the major land uses in the survey area.

Slick spot. A small area of soil having a puddled, crusted, or smooth surface and an excess of exchangeable sodium. The soil is generally silty or clayey, is slippery when wet, and is low in productivity.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical

distance divided by horizontal distance, then multipled by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance. In this survey area, the classes of slope are—

	Percent
Nearly level	0 to 2
Very gently sloping	1 to 4
Gently sloping	2 to 7
Strongly sloping	5 to 11
Moderately steep	9 to 20
Steep	17 to 30

Slope (in tables). Slope is great enough that special practices are required to ensure satisfactory performance of the soil for a specific use.

Slow intake (in tables). The slow movement of water into the soil.

Small stones (in tables). Rock fragments less than 3 inches (7.6 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows:

	Millimeters
Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A, E, and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum.

Stone line. A concentration of coarse fragments in a soil. Generally it is indicative of an old weathered surface. In a cross section, the line may be one fragment or more thick. It generally overlies material that weathered in place and is overlain by recent sediment of variable thickness.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grain* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Stubble mulch. Stubble or other crop residue left on the soil or partly worked into the soil. It protects the soil from soil blowing and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Subsurface layer. Any surface soil horizon (A, E, AB, or EB) below the surface layer.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from about 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Surface soil. The A, E, AB, and EB horizons. It includes all subdivisions of these horizons.

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that water soaks into the soil or flows slowly to a prepared outlet.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

Well graded. Refers to soil material consisting of coarse grained particles that are well distributed over a wide range in size or diameter. Such soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

Tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

[Recorded in the period 1951-80 at Tecumseh, Nebraska]

Month	Temperature						Precipitation				
	Average daily maximum	Average daily minimum	Average	2 years in 10 will have-- Maximum temperature higher than--	2 years in 10 will have-- Minimum temperature lower than--	Average number of growing degree days*	Average	2 years in 10 will have-- Less than--	2 years in 10 will have-- More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	Units	In	In	In		In
January----	33.0	10.5	21.8	61	-18	0	0.92	0.34	1.41	3	8.2
February---	40.0	16.8	28.4	70	-14	14	1.09	.34	1.71	3	6.7
March------	50.0	26.5	38.3	84	-3	40	2.33	.82	3.59	5	6.9
April------	65.0	39.3	52.2	89	18	131	2.90	1.55	4.07	6	.7
May--------	75.4	49.9	62.7	93	28	400	4.15	2.77	5.40	7	.0
June-------	84.6	59.9	72.3	101	41	669	4.47	2.06	6.53	7	.0
July-------	89.6	64.6	77.1	103	48	840	4.55	2.01	6.71	7	.0
August-----	87.8	62.2	75.0	102	45	775	4.30	1.39	6.68	6	.0
September--	79.3	52.4	65.9	99	30	477	3.68	1.38	5.59	6	.0
October----	69.1	40.4	54.8	91	20	201	2.59	.75	4.11	4	.1
November---	52.0	27.9	40.0	78	3	11	1.45	.27	2.37	3	2.1
December---	39.5	17.6	28.6	68	-12	0	.97	.33	1.49	3	4.5
Yearly:											
Average--	63.8	39.0	51.4	---	---	---	---	---	---	---	---
Extreme--	---	---	---	104	-20	---	---	---	---	---	---
Total----	---	---	---	---	---	3,558	33.40	26.34	40.09	60	29.2

* A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (50 degrees F).

TABLE 2.--FREEZE DATES IN SPRING AND FALL

[Recorded in the period 1951-80 at Tecumseh, Nebraska]

Probability	Temperature		
	24^{o} F or lower	28^{o} F or lower	32^{o} F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	Apr. 21	May 1	May 17
2 years in 10 later than--	Apr. 16	Apr. 27	May 12
5 years in 10 later than--	Apr. 6	Apr. 19	May 3
First freezing temperature in fall:			
1 year in 10 earlier than--	Oct. 14	Oct. 4	Sept. 23
2 years in 10 earlier than--	Oct. 19	Oct. 8	Sept. 27
5 years in 10 earlier than--	Oct. 28	Oct. 15	Oct. 6

TABLE 3.--GROWING SEASON

[Recorded in the period 1951-80 at Tecumseh, Nebraska]

Probability	Daily minimum temperature during growing season		
	Higher than 24^{o} F	Higher than 28^{o} F	Higher than 32^{o} F
	Days	Days	Days
9 years in 10	184	161	143
8 years in 10	191	167	147
5 years in 10	204	179	155
2 years in 10	217	191	163
1 year in 10	224	197	167

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
BrE2	Burchard-Steinauer clay loams, 9 to 15 percent slopes, eroded	9,460	3.9
DcD	Dickinson fine sandy loam, 6 to 11 percent slopes	1,350	0.6
DcF	Dickinson fine sandy loam, 11 to 20 percent slopes	1,070	0.4
JuC	Judson silt loam, 2 to 6 percent slopes	10,590	4.4
Ke	Kennebec silt loam, 0 to 1 percent slopes	5,960	2.5
KnB	Kennebec-Nodaway silt loams, 0 to 4 percent slopes	3,300	1.4
KpF	Kipson-Benfield complex, 11 to 25 percent slopes	1,730	0.7
MaD	Malcolm silt loam, 5 to 11 percent slopes	780	0.3
MaF	Malcolm silt loam, 11 to 25 percent slopes	1,400	0.6
MeC	Mayberry clay loam, 3 to 9 percent slopes	4,160	1.7
MfC2	Mayberry clay, 3 to 9 percent slopes, eroded	15,870	6.6
MrD	Morrill clay loam, 5 to 11 percent slopes	3,740	1.6
MrD2	Morrill clay loam, 5 to 11 percent slopes, eroded	9,000	3.7
Na	Nishna silty clay, 0 to 1 percent slopes	940	0.4
Nb	Nodaway silt loam, 0 to 1 percent slopes	14,930	6.2
Nf	Nodaway silt loam, channeled	6,170	2.6
PaC	Pawnee clay loam, 3 to 9 percent slopes	9,070	3.8
PaD	Pawnee clay loam, 9 to 12 percent slopes	1,390	0.6
PbC2	Pawnee clay, 3 to 9 percent slopes, eroded	39,710	16.3
PbD2	Pawnee clay, 9 to 12 percent slopes, eroded	2,220	0.9
ShB	Sharpsburg silty clay loam, 1 to 4 percent slopes	200	0.1
SkE	Shelby clay loam, 9 to 15 percent slopes	11,070	4.6
SkF	Shelby clay loam, 15 to 30 percent slopes	2,320	1.0
StF	Steinauer clay loam, 15 to 20 percent slopes	670	0.3
Wc	Wabash silty clay, 0 to 1 percent slopes	780	0.3
Wt	Wymore silty clay loam, 0 to 2 percent slopes	6,820	2.8
WtC	Wymore silty clay loam, 2 to 7 percent slopes	3,190	1.3
WyC2	Wymore silty clay, 2 to 7 percent slopes, eroded	60,171	25.0
Zh	Zoe-Zook silty clay loams, 0 to 1 percent slopes	460	0.2
Zo	Zook silty clay loam, 0 to 1 percent slopes	10,630	4.4
	Water areas less than 40 acres in size	1,950	0.8
	Total	241,101	100.0

TABLE 5.--DRYLAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS AND PASTURE

[Yields are those that can be expected under an average level of management in column A and under a high level of management in column B. Absence of a yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil]

Soil name and map symbol	Dryland capability	Corn A	Corn B	Grain sorghum A	Grain sorghum B	Soybeans A	Soybeans B	Alfalfa hay A	Alfalfa hay B	Winter wheat A	Winter wheat B	Cool-season grass A	Cool-season grass B
		Bu	Bu	Bu	Bu	Bu	Bu	Tons	Tons	Bu	Bu	AUM*	AUM*
BrE2------------ Burchard-Steinauer	IVe	44	55	52	68	20	23	3.2	4.0	28	32	3.0	3.8
DcD------------- Dickinson	IVe	44	55	52	68	20	23	2.2	2.8	28	32	2.8	3.5
DcF------------- Dickinson	VIe	---	---	---	---	---	---	---	---	---	---	---	---
JuC------------- Judson	IIe	86	108	75	98	37	42	3.8	4.8	39	44	4.6	5.8
Ke-------------- Kennebec	I	92	115	79	103	39	44	4.0	5.0	39	44	4.8	6.0
KnB------------- Kennebec-Nodaway	IIw	80	100	70	90	35	40	3.8	4.8	37	42	4.6	5.8
KpF------------- Kipson-Benfield	VIs	---	---	---	---	---	---	---	---	---	---	---	---
MaD------------- Malcolm	IVe	54	67	56	69	24	28	2.9	3.6	30	34	3.6	4.5
MaF------------- Malcolm	VIe	---	---	---	---	---	---	---	---	---	---	---	---
MeC------------- Mayberry	IIIe	52	65	55	71	24	27	2.8	3.5	33	37	3.2	4.0
MfC2------------ Mayberry	IVe	40	55	47	60	19	22	2.2	2.8	28	32	2.6	3.3
MrD------------- Morrill	IIIe	54	68	57	74	24	28	2.4	3.0	32	35	3.2	4.0
MrD2------------ Morrill	IVe	52	65	52	67	22	25	2.6	3.4	30	34	3.6	4.5
Na-------------- Nishna	IIIw	55	68	54	69	28	33	---	---	28	32	4.4	5.5
Nb-------------- Nodaway	IIw	84	105	73	95	35	40	4.0	5.0	33	37	4.8	6.0
Nf-------------- Nodaway	VIw	---	---	---	---	---	---	---	---	---	---	2.8	3.5
PaC------------- Pawnee	IIIe	52	65	55	71	24	27	2.8	3.5	33	37	3.2	4.0
PaD------------- Pawnee	IVe	48	60	51	61	22	25	2.6	3.8	30	34	2.8	3.5

See footnote at end of table.

TABLE 5.--DRYLAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Dryland capability	Corn		Grain sorghum		Soybeans		Alfalfa hay		Winter wheat		Cool-season grass	
		A	B	A	B	A	B	A	B	A	B	A	B
		Bu	Bu	Bu	Bu	Bu	Bu	Tons	Tons	Bu	Bu	AUM*	AUM*
PbC2------------ Pawnee	IVe	42	57	50	62	20	23	2.2	2.8	29	32	2.8	3.5
PbD2------------ Pawnee	VIe	---	---	---	---	---	---	---	---	---	---	---	---
ShB------------- Sharpsburg	IIe	72	90	65	85	32	37	3.6	4.5	39	44	---	---
SkE------------- Shelby	IVe	50	60	57	74	22	25	3.2	4.0	30	34	3.6	4.5
SkF------------- Shelby	VIe	---	---	---	---	---	---	---	---	---	---	---	---
StF------------- Steinauer	VIe	---	---	---	---	---	---	---	---	---	---	---	---
Wc-------------- Wabash	IIIw	50	63	50	65	27	32	---	---	---	---	4.0	5.0
Wt-------------- Wymore	IIs	62	78	65	85	29	34	3.2	4.0	37	42	3.6	4.5
WtC------------- Wymore	IIIe	59	74	63	82	27	31	3.0	3.8	35	39	3.6	4.5
WyC2------------ Wymore	IIIe	54	68	57	74	24	28	2.4	3.0	32	35	3.2	4.0
Zh-------------- Zoe-Zook	IVs	42	52	45	59	20	23	---	---	---	---	---	---
Zo-------------- Zook	IIw	72	89	67	89	32	36	3.8	---	---	---	4.4	5.5

* Animal-unit-month: The amount of forage or feed required to feed one animal unit (one cow, one horse, one mule, five sheep, or five goats) for 30 days.

TABLE 6.--IRRIGATED LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS

[Yields are those that can be expected under a high level of management. Absence of a yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil]

Soil name and map symbol	Irrigated land capability	Corn	Grain sorghum	Soybeans
		Bu	Bu	Bu
BrE2 Burchard-Steinauer	IVe	80	81	---
DcD Dickinson	IVe	90	81	35
DcF. Dickinson				
JuC Judson	IIIe	140	113	52
Ke Kennebec	I	150	117	55
KnB Kennebec-Nodaway	IIw	130	103	48
KpF. Kipson-Benfield				
MaD Malcolm	IVe	100	90	---
MaF. Malcolm				
MeC Mayberry	IVe	85	77	35
MfC2 Mayberry	IVe	80	72	33
MrD Morrill	IVe	95	85	38
MrD2 Morrill	IVe	90	80	33
Na Nishna	IIIw	105	95	39
Nb Nodaway	IIw	135	112	48
Nf. Nodaway				
PaC Pawnee	IVe	90	81	38
PaD. Pawnee				
PbC2 Pawnee	IVe	85	77	35
PbD2. Pawnee				

TABLE 6.--IRRIGATED LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS--Continued

Soil name and map symbol	Irrigated land capability	Corn	Grain sorghum	Soybeans
		Bu	Bu	Bu
ShB------------------------ Sharpsburg	IIIe	130	104	48
SkE------------------------ Shelby	IVe	90	81	---
SkF. Shelby				
StF. Steinauer				
Wc------------------------- Wabash	IIIw	100	86	38
Wt------------------------- Wymore	IIs	120	104	48
WtC------------------------ Wymore	IIIe	115	98	45
WyC2----------------------- Wymore	IVe	105	88	40
Zh------------------------- Zoe-Zook	IVs	80	81	32
Zo------------------------- Zook	IIw	120	113	52

TABLE 7.--PRIME FARMLAND

[Only the soils considered prime farmland are listed. Urban or built-up areas of the soils listed are not considered prime farmland. If a soil is prime farmland only under certain conditions, the conditions are specified in parentheses after the soil name]

Map symbol	Soil name
JuC	Judson silt loam, 2 to 6 percent slopes
Ke	Kennebec silt loam, 0 to 1 percent slopes
KnB	Kennebec-Nodaway silt loams, 0 to 4 percent slopes
Na	Nishna silty clay, 0 to 1 percent slopes (where drained)*
Nb	Nodaway silt loam, 0 to 1 percent slopes
ShB	Sharpsburg silty clay loam, 1 to 4 percent slopes
Wt	Wymore silty clay loam, 0 to 2 percent slopes
WtC	Wymore silty clay loam, 2 to 7 percent slopes
WyC2	Wymore silty clay, 2 to 7 percent slopes, eroded
Zo	Zook silty clay loam, 0 to 1 percent slopes (where drained)*

* These soils generally have been adequately drained either by the application of drainage measures or by incidental drainage that results from farming operations, road building, and other kinds of land development.

TABLE 8.--CAPABILITY CLASSES AND SUBCLASSES

[All soils are assigned to nonirrigated capability subclasses (N). Only potentially irrigable soils are assigned to irrigated subclasses (I). Miscellaneous areas are excluded. Absence of an entry indicates no acreage]

Class	Total acreage	Major management concerns (Subclass)			
		Erosion (e)	Wetness (w)	Soil problem (s)	Climate (c)
		Acres	Acres	Acres	Acres
I (N)	5,960	---	---	---	---
(I)	5,960	---	---	---	---
II (N)	46,470	10,790	28,860	6,820	---
(I)	35,680	---	28,860	6,820	---
III (N)	82,051	80,331	1,720	---	---
(I)	15,780	14,060	1,720	---	---
IV (N)	89,090	88,630	---	460	---
(I)	164,841	164,381	---	460	---
V (N)	---	---	---	---	---
VI (N)	15,580	7,680	6,170	1,730	---
VII (N)	---	---	---	---	---
VIII (N)	---	---	---	---	---

TABLE 9.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES

Soil name and map symbol	Range site	Total production: Kind of year	Total production: Dry weight	Characteristic vegetation	Composition
			Lb/acre		Pct
BrE2*:					
Burchard	Silty	Favorable	4,400	Big bluestem	30
		Normal	3,900	Little bluestem	20
		Unfavorable	3,500	Indiangrass	10
				Switchgrass	10
				Sideoats grama	10
				Prairie dropseed	5
				Sedge	5
Steinauer	Limy Upland	Favorable	3,200	Little bluestem	35
		Normal	2,700	Big bluestem	20
		Unfavorable	2,500	Sideoats grama	10
				Indiangrass	10
				Tall dropseed	5
				Sedge	5
DcD, DcF: Dickinson	Sandy	Favorable	3,700	Little bluestem	25
		Normal	3,400	Big bluestem	20
		Unfavorable	3,100	Indiangrass	10
				Switchgrass	10
				Porcupinegrass	10
				Prairie sandreed	10
JuC: Judson	Silty	Favorable	4,800	Big bluestem	30
		Normal	4,400	Little bluestem	25
		Unfavorable	4,000	Porcupinegrass	10
				Switchgrass	5
				Indiangrass	5
				Sideoats grama	5
Ke: Kennebec	Silty Lowland	Favorable	5,300	Big bluestem	40
		Normal	4,900	Little bluestem	25
		Unfavorable	4,500	Switchgrass	10
				Indiangrass	5
				Sideoats grama	5
KnB*:					
Kennebec	Silty Lowland	Favorable	5,300	Big bluestem	40
		Normal	4,900	Little bluestem	25
		Unfavorable	4,500	Switchgrass	10
				Indiangrass	5
				Sideoats grama	5
Nodaway	Silty Overflow	Favorable	5,000	Big bluestem	30
		Normal	4,200	Little bluestem	10
		Unfavorable	3,500	Switchgrass	10
				Western wheatgrass	10
				Porcupinegrass	10
				Indiangrass	5
				Kentucky bluegrass	5
				Sedge	5
				Sideoats grama	5
KpF*:					
Kipson	Shallow Limy	Favorable	3,000	Big bluestem	30
		Normal	2,700	Little bluestem	25
		Unfavorable	2,400	Sideoats grama	10
				Indiangrass	5

See footnote at end of table.

TABLE 9.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES--Continued

Soil name and map symbol	Range site	Total production: Kind of year	Total production: Dry weight	Characteristic vegetation	Composition
			Lb/acre		Pct
KpF*:					
Benfield	Clayey	Favorable	4,100	Big bluestem	25
		Normal	3,600	Little bluestem	20
		Unfavorable	3,200	Indiangrass	10
				Switchgrass	10
				Tall dropseed	5
				Sideoats grama	5
MaD, MaF	Silty	Favorable	4,400	Big bluestem	25
Malcolm		Normal	3,900	Little bluestem	20
		Unfavorable	3,500	Indiangrass	10
				Switchgrass	5
				Sideoats grama	5
				Sedge	5
				Prairie dropseed	5
				Prairie junegrass	5
				Tall dropseed	5
MeC	Clayey	Favorable	4,100	Big bluestem	25
Mayberry		Normal	3,600	Little bluestem	20
		Unfavorable	3,200	Switchgrass	10
				Indiangrass	10
				Tall dropseed	5
				Sideoats grama	5
				Prairie dropseed	5
				Sedge	5
MfC2	Dense Clay	Favorable	3,200	Switchgrass	20
Mayberry		Normal	2,700	Big bluestem	15
		Unfavorable	2,000	Little bluestem	10
				Tall dropseed	10
				Indiangrass	5
				Sideoats grama	5
				Blue grama	5
				Sedge	5
MrD, MrD2	Silty	Favorable	4,400	Big bluestem	30
Morrill		Normal	3,900	Little bluestem	20
		Unfavorable	3,500	Indiangrass	10
				Switchgrass	5
				Sideoats grama	5
Na	Clayey Overflow	Favorable	4,000	Big bluestem	40
Nishna		Normal	3,800	Switchgrass	20
		Unfavorable	3,500	Little bluestem	15
				Indiangrass	10
				Western wheatgrass	5
Nb, Nf	Silty Overflow	Favorable	5,000	Big bluestem	30
Nodaway		Normal	4,200	Little bluestem	10
		Unfavorable	3,500	Switchgrass	10
				Western wheatgrass	10
				Indiangrass	5
				Sedge	5
				Sideoats grama	5

See footnote at end of table.

TABLE 9.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES--Continued

Soil name and map symbol	Range site	Total production: Kind of year	Total production: Dry weight	Characteristic vegetation	Composition
			Lb/acre		Pct
PaC, PaD: Pawnee	Clayey	Favorable	4,100	Big bluestem	25
		Normal	3,600	Little bluestem	25
		Unfavorable	3,200	Switchgrass	10
				Tall dropseed	5
				Sideoats grama	5
				Indiangrass	5
				Porcupinegrass	5
				Prairie dropseed	5
PbC2, PbD2: Pawnee	Dense Clay	Favorable	2,500	Big bluestem	25
		Normal	2,000	Switchgrass	20
		Unfavorable	1,500	Little bluestem	15
				Tall dropseed	10
				Indiangrass	10
				Sideoats grama	5
ShB: Sharpsburg	Silty	Favorable	4,800	Big bluestem	30
		Normal	4,400	Little bluestem	20
		Unfavorable	4,000	Switchgrass	10
				Sideoats grama	5
				Indiangrass	5
				Tall dropseed	5
				Sedge	5
SkE, SkF: Shelby	Silty	Favorable	4,400	Big bluestem	30
		Normal	3,900	Little bluestem	25
		Unfavorable	3,500	Indiangrass	10
				Switchgrass	5
				Sideoats grama	5
				Porcupinegrass	5
				Prairie dropseed	5
				Sedge	5
StF: Steinauer	Limy Upland	Favorable	3,200	Little bluestem	35
		Normal	2,700	Big bluestem	20
		Unfavorable	2,500	Sideoats grama	10
				Indiangrass	10
				Tall dropseed	5
				Sedge	5
Wc: Wabash	Clayey Overflow	Favorable	4,500	Big bluestem	30
		Normal	4,100	Switchgrass	20
		Unfavorable	3,700	Little bluestem	20
				Indiangrass	10
Wt, WtC, WyC2: Wymore	Clayey	Favorable	4,500	Big bluestem	30
		Normal	4,100	Little bluestem	20
		Unfavorable	3,700	Switchgrass	10
				Indiangrass	5
				Sideoats grama	5
				Prairie dropseed	5
				Tall dropseed	5
				Sedge	5
Zh*:					
Zoe	Saline Subirrigated	Favorable	4,500	Western wheatgrass	20
		Normal	4,300	Switchgrass	15
		Unfavorable	4,000	Inland saltgrass	10
				Slender wheatgrass	10
				Sedge	5
				Kentucky bluegrass	5
				Blue grama	5

See footnote at end of table.

TABLE 9.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES--Continued

Soil name and map symbol	Range site	Total production		Characteristic vegetation	Compo-sition
		Kind of year	Dry weight		
			Lb/acre		Pct
Zh*:					
Zook	Clayey Overflow	Favorable	4,600	Big bluestem	35
		Normal	4,100	Switchgrass	20
		Unfavorable	3,700	Little bluestem	20
				Indiangrass	10
Zo	Clayey Overflow	Favorable	4,800	Big bluestem	35
Zook		Normal	4,200	Switchgrass	20
		Unfavorable	3,800	Little bluestem	20
				Indiangrass	10

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

[The symbol < means less than; > means more than. Absence of an entry indicates that trees generally do not grow to the given height on that soil]

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of-- <8	8-15	16-25	26-35	>35
BrE2*:					
Burchard	Peking cotoneaster	Tatarian honeysuckle, lilac, American plum.	Eastern redcedar, Russian mulberry, green ash, hackberry, bur oak.	Austrian pine, Scotch pine, honeylocust.	---
Steinauer	Fragrant sumac, Tatarian honeysuckle.	Siberian peashrub	Russian-olive, eastern redcedar, bur oak, black locust, osageorange, green ash, honeylocust, northern catalpa.	Siberian elm	---
DcD, DcF: Dickinson	Fragrant sumac, Amur honeysuckle, lilac.	Autumn-olive	Eastern redcedar, Russian-olive, bur oak.	Honeylocust, Austrian pine, eastern white pine, hackberry, green ash.	---
JuC: Judson	---	Amur honeysuckle, Amur maple, autumn-olive, lilac.	Hackberry, bur oak, green ash, Russian-olive, eastern redcedar.	Honeylocust, Austrian pine, eastern white pine.	---
Ke: Kennebec	---	Amur maple, autumn-olive, Amur honeysuckle, lilac.	Eastern redcedar	Eastern white pine, honeylocust, Austrian pine, pin oak, hackberry, green ash.	Eastern cottonwood.
KnB*:					
Kennebec	---	Amur maple, autumn-olive, Amur honeysuckle, lilac.	Eastern redcedar	Eastern white pine, honeylocust, Austrian pine, pin oak, hackberry, green ash.	Eastern cottonwood.
Nodaway	---	Amur honeysuckle, autumn-olive, Amur maple, lilac.	Eastern redcedar	Austrian pine, hackberry, honeylocust, green ash, eastern white pine, pin oak.	Eastern cottonwood.
KpF*:					
Kipson.					
Benfield.					

See footnote at end of table.

TABLE 10.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of-- <8	8-15	16-25	26-35	>35
MaD, MaF. Malcolm	Peking cotoneaster, lilac.	Amur honeysuckle, skunkbush sumac.	Eastern redcedar, green ash, bur oak, hackberry, Russian mulberry.	Austrian pine, Scotch pine, honeylocust.	---
MeC, MfC2. Mayberry	Siberian peashrub, Amur honeysuckle, lilac.	Eastern redcedar, Manchurian crabapple, autumn-olive.	Russian-olive, Austrian pine, jack pine, green ash, hackberry, honeylocust.	---	---
MrD, MrD2. Morrill	Peking cotoneaster	Amur honeysuckle, lilac, fragrant sumac.	Green ash, hackberry, Russian-olive, eastern redcedar, bur oak.	Austrian pine, honeylocust, Scotch pine.	---
Na. Nishna	Lilac	Tatarian honeysuckle, common chokecherry.	Russian-olive, eastern redcedar, blue spruce, hackberry.	Honeylocust, green ash, golden willow, Austrian pine.	Eastern cottonwood.
Nb. Nodaway	---	Amur honeysuckle, autumn-olive, Amur maple, lilac.	Eastern redcedar	Austrian pine, hackberry, honeylocust, green ash, eastern white pine, pin oak.	Eastern cottonwood.
Nf. Nodaway					
PaC, PaD, PbC2, PbD2. Pawnee	Amur honeysuckle, lilac, Siberian peashrub, Peking cotoneaster.	Eastern redcedar, Manchurian crabapple.	Austrian pine, Russian-olive, green ash, hackberry, honeylocust.	Siberian elm	---
ShB. Sharpsburg	---	Amur maple, Amur honeysuckle, lilac, autumn-olive.	Green ash, hackberry, bur oak, eastern redcedar, Russian-olive.	Austrian pine, eastern white pine, honeylocust.	---
SkE. Shelby	---	Autumn-olive, lilac, Amur honeysuckle, Amur maple.	Eastern redcedar, Russian-olive, hackberry, bur oak, green ash.	Austrian pine, eastern white pine, honeylocust.	---
SkF. Shelby					
StF. Steinauer	Fragrant sumac, Tatarian honeysuckle, lilac.	---	Russian-olive, eastern redcedar, bur oak, osage-orange, black locust, green ash, honeylocust, northern catalpa.	Siberian elm	---

See footnote at end of table.

TABLE 10.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
Wc----------------- Wabash	Redosier dogwood	American plum, common chokecherry.	Eastern redcedar, hackberry.	Austrian pine, green ash, northern red oak, golden willow, honeylocust, silver maple.	Eastern cottonwood.
Wt, WtC, WyC2----- Wymore	Peking cotoneaster, skunkbush sumac, lilac.	Manchurian crabapple, Amur honeysuckle.	Eastern redcedar, Austrian pine, Scotch pine, Russian-olive, hackberry, green ash.	Honeylocust--------	---
Zh*:					
Zoe---------------	Tatarian honeysuckle, lilac, silver buffaloberry.	Eastern redcedar, Siberian peashrub.	Green ash, Russian-olive.	White willow, golden willow, Siberian elm.	Eastern cottonwood.
Zook--------------	Redosier dogwood	American plum, common chokecherry.	Eastern redcedar, hackberry.	Honeylocust, golden willow, green ash, northern red oak, silver maple, Austrian pine.	Eastern cottonwood.
Zo----------------- Zook	Redosier dogwood	American plum, common chokecherry.	Eastern redcedar, hackberry.	Honeylocust, golden willow, green ash, northern red oak, silver maple, Austrian pine.	Eastern cottonwood.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--RECREATIONAL DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe"]

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
BrE2*:				
Burchard	Moderate: slope, percs slowly.	Moderate: slope, percs slowly.	Severe: slope.	Slight.
Steinauer	Moderate: percs slowly, slope.	Moderate: slope, percs slowly.	Severe: slope.	Slight.
DcD Dickinson	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
DcF Dickinson	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
JuC Judson	Slight	Slight	Moderate: slope.	Slight.
Ke Kennebec	Severe: flooding.	Slight	Slight	Slight.
KnB*:				
Kennebec	Severe: flooding.	Slight	Slight	Slight.
Nodaway	Severe: flooding.	Slight	Moderate: flooding.	Slight.
KpF*:				
Kipson	Severe: slope, depth to rock.	Severe: slope, depth to rock.	Severe: large stones, small stones, depth to rock.	Moderate: large stones, slope.
Benfield	Severe: slope.	Severe: slope.	Severe: slope.	Severe: erodes easily.
MaD Malcolm	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
MaF Malcolm	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
MeC Mayberry	Severe: wetness.	Moderate: wetness.	Severe: slope, wetness.	Slight.
MfC2 Mayberry	Severe: wetness, too clayey.	Severe: too clayey.	Severe: slope, too clayey, wetness.	Severe: too clayey.
MrD Morrill	Slight	Slight	Severe: slope.	Slight.
MrD2 Morrill	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.

See footnote at end of table.

TABLE 11.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Na: Nishna	Severe: flooding, wetness, too clayey.	Severe: too clayey.	Severe: too clayey, wetness.	Severe: too clayey.
Nb: Nodaway	Severe: flooding.	Slight	Moderate: flooding.	Slight.
Nf: Nodaway	Severe: flooding.	Moderate: flooding.	Severe: flooding.	Moderate: flooding.
PaC: Pawnee	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.
PaD: Pawnee	Severe: wetness.	Moderate: slope, wetness.	Severe: slope, wetness.	Severe: erodes easily.
PbC2: Pawnee	Severe: too clayey, wetness.	Severe: too clayey.	Severe: slope, too clayey, wetness.	Severe: too clayey.
PbD2: Pawnee	Severe: too clayey, wetness.	Severe: too clayey.	Severe: slope, too clayey, wetness.	Severe: too clayey, erodes easily.
ShB: Sharpsburg	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: slope, percs slowly.	Slight.
SkE: Shelby	Moderate: slope, percs slowly.	Moderate: slope, percs slowly.	Severe: slope.	Slight.
SkF: Shelby	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
StF: Steinauer	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
Wc: Wabash	Severe: flooding, wetness, percs slowly.	Severe: wetness, too clayey, percs slowly.	Severe: too clayey, wetness.	Severe: wetness, too clayey.
Wt, WtC: Wymore	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.
WyC2: Wymore	Severe: wetness, too clayey.	Severe: too clayey.	Severe: too clayey, wetness.	Severe: too clayey.
Zh*:				
Zoe	Severe: flooding, wetness.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.

See footnote at end of table.

TABLE 11.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Zh*:				
Zook	Severe: wetness, flooding.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.
Zo Zook	Severe: wetness, flooding.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--WILDLIFE HABITAT

[See text for definitions of "good," "fair," "poor," and "very poor"]

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Shrubs	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Woodland wildlife	Wetland wildlife	Rangeland wildlife
BrE2*:												
Burchard	Fair	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.	Good.
Steinauer	Fair	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.	Good.
DcD Dickinson	Fair	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.	Good.
DcF Dickinson	Poor	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.	Good.
JuC Judson	Good	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor	Good.
Ke Kennebec	Good	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor	Good.
KnB*:												
Kennebec	Good	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor	Good.
Nodaway	Good	Good	Good	Good	Fair	Good	Fair	Poor	Good	Good	Fair	Good.
KpF*:												
Kipson	Poor	Fair	Fair	Poor	Poor	Poor	Very poor.	Very poor.	Fair	Poor	Very poor.	Fair.
Benfield	Poor	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.	Fair.
MaD Malcolm	Fair	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.	Good.
MaF Malcolm	Poor	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.	Good.
MeC, MfC2 Mayberry	Fair	Good	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.	Fair.
MrD, MrD2 Morrill	Fair	Good	Good	Fair	Fair	Good	Very poor.	Very poor.	Good	Fair	Very poor.	Good.
Na Nishna	Fair	Fair	Fair	Poor	Very poor.	Fair	Good	Good	Fair	Poor	Good	Fair.
Nb Nodaway	Good	Good	Good	Good	Fair	Good	Poor	Poor	Good	Good	Poor	Good.
Nf Nodaway	Poor	Fair	Fair	Poor	Poor	Good	Good	Fair	Poor	Poor	Fair	Good.
PaC, PaD, PbC2 Pawnee	Fair	Good	Good	Fair	Fair	Fair	Very poor.	Poor	Good	Fair	Very poor.	Fair.

See footnote at end of table.

TABLE 12.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements								Potential as habitat for--			
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife	Rangeland wildlife
PbD2: Pawnee	Fair	Fair	Good	Fair	Fair	Fair	Very poor.	Poor	Fair	Fair	Very poor.	Fair.
ShB: Sharpsburg	Good	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor	Good.
SkE: Shelby	Fair	Good	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.	Good.
SkF: Shelby	Poor	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.	Fair.
StF: Steinauer	Poor	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.	Good.
Wc: Wabash	Poor	Poor	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good	Fair.
Wt: Wymore	Good	Good	Fair	Good	Good	Fair	Poor	Very poor.	Good	Good	Very poor.	Fair.
WtC, WyC2: Wymore	Fair	Good	Fair	Good	Good	Fair	Very poor.	Very poor.	Fair	Good	Very poor.	Fair.
Zh*:												
Zoe	Poor	Fair	Fair	Fair	Fair	Fair	Good	Good	Poor	Fair	Good	Fair.
Zook	Good	Fair	Good	Fair	Poor	Fair	Good	Good	Fair	Fair	Good	Good.
Zo: Zook	Good	Fair	Good	Fair	Poor	Fair	Good	Good	Fair	Fair	Good	Good.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--BUILDING SITE DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation]

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
BrE2*:						
Burchard	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.	Moderate: slope.
Steinauer	Moderate: slope.	Moderate: slope, shrink-swell.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.	Moderate: slope.
DcD Dickinson	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: slope.
DcF Dickinson	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
JuC Judson	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength, frost action.	Slight.
Ke Kennebec	Moderate: wetness.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, frost action.	Slight.
KnB*:						
Kennebec	Moderate: wetness.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, frost action.	Slight.
Nodaway	Moderate: wetness, flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding, frost action, low strength.	Moderate: flooding.
KpF*:						
Kipson	Severe: depth to rock, slope.	Severe: slope.	Severe: depth to rock, slope.	Severe: slope.	Severe: slope.	Severe: large stones, slope, thin layer.
Benfield	Severe: slope.	Severe: shrink-swell, slope.	Severe: slope, shrink-swell.	Severe: shrink-swell, slope.	Severe: low strength, slope, shrink-swell.	Severe: slope.
MaD Malcolm	Moderate: slope.	Moderate: slope, shrink-swell.	Moderate: slope.	Severe: slope.	Severe: frost action, low strength.	Moderate: slope.
MaF Malcolm	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope, frost action, low strength.	Severe: slope.

See footnote at end of table.

TABLE 13.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
MeC: Mayberry	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: low strength, frost action, shrink-swell.	Moderate: wetness.
MfC2: Mayberry	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: low strength, frost action, shrink-swell.	Severe: too clayey.
MrD: Morrill	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: low strength, frost action.	Slight.
MrD2: Morrill	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Moderate: low strength, slope, frost action.	Moderate: slope.
Na: Nishna	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: shrink-swell, wetness, flooding.	Severe: flooding, low strength, shrink-swell.	Severe: too clayey.
Nb: Nodaway	Moderate: wetness, flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding, frost action, low strength.	Moderate: flooding.
Nf: Nodaway	Moderate: wetness, flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding, frost action, low strength.	Severe: flooding.
PaC: Pawnee	Severe: wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, wetness.	Severe: low strength, frost action, shrink-swell.	Moderate: wetness.
PaD: Pawnee	Severe: wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, slope, wetness.	Severe: low strength, frost action, shrink-swell.	Moderate: slope, wetness.
PbC2: Pawnee	Severe: wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, wetness.	Severe: low strength, frost action, shrink-swell.	Severe: too clayey.
PbD2: Pawnee	Severe: wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, slope, wetness.	Severe: low strength, frost action, shrink-swell.	Severe: too clayey.
ShB: Sharpsburg	Moderate: too clayey.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.	Slight.
SkE: Shelby	Moderate: slope.	Moderate: slope, shrink-swell.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.	Moderate: slope.

See footnote at end of table.

TABLE 13.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
SkF: Shelby	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.	Severe: slope.
StF: Steinauer	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope, low strength.	Severe: slope.
Wc: Wabash	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: low strength, wetness, flooding.	Severe: wetness, too clayey.
Wt, WtC: Wymore	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: low strength, frost action.	Moderate: wetness.
WyC2: Wymore	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: low strength, frost action.	Severe: too clayey.
Zh*:						
Zoe	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: low strength, flooding, frost action.	Moderate: wetness, flooding.
Zook	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, low strength, frost action.	Moderate: wetness, flooding.
Zo: Zook	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, low strength, frost action.	Moderate: wetness, flooding.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--SANITARY FACILITIES

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "good," and other terms. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation]

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
BrE2*:					
Burchard	Severe: percs slowly.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
Steinauer	Severe: percs slowly.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
DcD: Dickinson	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
DcF: Dickinson	Severe: slope, poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy, slope.	Severe: seepage, slope.	Poor: slope, seepage, too sandy.
JuC: Judson	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
Ke: Kennebec	Moderate: flooding, wetness, percs slowly.	Moderate: seepage.	Severe: wetness.	Moderate: flooding, wetness.	Good.
KnB*:					
Kennebec	Moderate: flooding, wetness, percs slowly.	Moderate: seepage.	Severe: wetness.	Moderate: flooding, wetness.	Good.
Nodaway	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Fair: wetness.
KpF*:					
Kipson	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Poor: area reclaim, small stones, slope.
Benfield	Severe: depth to rock, percs slowly, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope, too clayey.	Severe: depth to rock, slope.	Poor: area reclaim, too clayey, hard to pack.
MaD: Malcolm	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
MaF: Malcolm	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.

See footnote at end of table.

TABLE 14.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
MeC, MfC2----------- Mayberry	Severe: wetness, percs slowly.	Moderate: slope.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
MrD---------------- Morrill	Moderate: percs slowly, slope.	Moderate: seepage, slope.	Moderate: too clayey.	Slight-----------	Fair: too clayey.
MrD2--------------- Morrill	Moderate: percs slowly, slope.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
Na----------------- Nishna	Severe: flooding, percs slowly, wetness.	Slight-----------	Severe: flooding, wetness, too clayey.	Severe: flooding, wetness.	Poor: too clayey, hard to pack, wetness.
Nb, Nf------------- Nodaway	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Fair: wetness.
PaC---------------- Pawnee	Severe: percs slowly, wetness.	Moderate: slope.	Severe: too clayey, wetness.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
PaD---------------- Pawnee	Severe: percs slowly, wetness.	Severe: slope.	Severe: too clayey, wetness.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
PbC2--------------- Pawnee	Severe: percs slowly, wetness.	Moderate: slope.	Severe: too clayey, wetness.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
PbD2--------------- Pawnee	Severe: percs slowly, wetness.	Severe: slope.	Severe: too clayey, wetness.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
ShB---------------- Sharpsburg	Moderate: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight-----------	Fair: too clayey.
SkE---------------- Shelby	Severe: percs slowly.	Severe: slope.	Moderate: too clayey, slope.	Moderate: slope.	Fair: too clayey, slope.
SkF---------------- Shelby	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
StF---------------- Steinauer	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.

See footnote at end of table.

TABLE 14.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Wc: Wabash	Severe: flooding, wetness, percs slowly.	Severe: flooding.	Severe: flooding, wetness, too clayey.	Severe: flooding, wetness.	Poor: too clayey, hard to pack, wetness.
Wt: Wymore	Severe: wetness, percs slowly.	Slight	Severe: wetness.	Severe: wetness.	Poor: hard to pack, wetness.
WtC, WyC2: Wymore	Severe: wetness, percs slowly.	Moderate: slope.	Severe: wetness.	Severe: wetness.	Poor: hard to pack, wetness.
Zh*:					
Zoe	Severe: flooding, wetness, percs slowly.	Severe: wetness.	Severe: flooding, wetness, too clayey.	Severe: flooding, wetness.	Poor: too clayey, hard to pack, wetness.
Zook	Severe: percs slowly, wetness, flooding.	Severe: flooding.	Severe: wetness, too clayey, flooding.	Severe: wetness, flooding.	Poor: too clayey, wetness, hard to pack.
Zo: Zook	Severe: percs slowly, wetness, flooding.	Severe: flooding.	Severe: wetness, too clayey, flooding.	Severe: wetness, flooding.	Poor: too clayey, wetness, hard to pack.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--CONSTRUCTION MATERIALS

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," and other terms. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation]

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
BrE2*:				
Burchard	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones, slope.
Steinauer	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope, small stones.
DcD Dickinson	Good	Probable	Improbable: too sandy.	Fair: slope.
DcF Dickinson	Fair: slope.	Probable	Improbable: too sandy.	Poor: slope.
JuC Judson	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Ke Kennebec	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
KnB*:				
Kennebec	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Nodaway	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
KpF*:				
Kipson	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, small stones, slope.
Benfield	Poor: area reclaim, low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, slope.
MaD Malcolm	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
MaF Malcolm	Fair: low strength, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
MeC Mayberry	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones.
MfC2 Mayberry	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
MrD Morrill	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.

See footnote at end of table.

TABLE 15.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
MrD2------------------ Morrill	Good-----------------	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
Na-------------------- Nishna	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
Nb, Nf---------------- Nodaway	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
PaC------------------- Pawnee	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
PaD------------------- Pawnee	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, slope.
PbC2, PbD2------------ Pawnee	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
ShB------------------- Sharpsburg	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
SkE------------------- Shelby	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, slope.
SkF------------------- Shelby	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
StF------------------- Steinauer	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Wc-------------------- Wabash	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
Wt, WtC--------------- Wymore	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
WyC2------------------ Wymore	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
Zh*:				
Zoe-------------------	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
Zook------------------	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
Zo-------------------- Zook	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 16.--WATER MANAGEMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation]

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
BrE2*:						
Burchard	Severe: slope.	Slight	Deep to water	Slope	Slope	Slope.
Steinauer	Severe: slope.	Moderate: piping.	Deep to water	Slope	Slope	Slope.
DcD, DcF Dickinson	Severe: slope, seepage.	Severe: piping.	Deep to water	Soil blowing, slope.	Soil blowing, slope.	Slope.
JuC Judson	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
Ke Kennebec	Moderate: seepage.	Moderate: thin layer, piping.	Deep to water	Favorable	Favorable	Favorable.
KnB*:						
Kennebec	Moderate: seepage.	Moderate: thin layer, piping.	Deep to water	Favorable	Favorable	Favorable.
Nodaway	Moderate: seepage.	Severe: piping.	Deep to water	Flooding, erodes easily.	Erodes easily	Erodes easily.
KpF*:						
Kipson	Severe: depth to rock, slope.	Severe: piping.	Deep to water	Large stones, depth to rock, slope.	Slope, large stones, depth to rock.	Large stones, slope, depth to rock.
Benfield	Severe: slope.	Moderate: thin layer, hard to pack.	Deep to water	Percs slowly, depth to rock, slope.	Slope, depth to rock, erodes easily.	Slope, erodes easily, depth to rock.
MaD, MaF Malcolm	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
MeC Mayberry	Moderate: slope.	Moderate: hard to pack, wetness.	Percs slowly, frost action, slope.	Wetness, percs slowly.	Erodes easily, wetness.	Wetness, erodes easily.
MfC2 Mayberry	Moderate: slope.	Moderate: hard to pack, wetness.	Percs slowly, frost action, slope.	Wetness, slow intake, percs slowly.	Erodes easily, wetness.	Wetness, erodes easily.
MrD Morrill	Moderate: seepage, slope.	Severe: thin layer.	Deep to water	Slope	Favorable	Favorable.
MrD2 Morrill	Severe: slope.	Severe: thin layer.	Deep to water	Slope	Slope	Slope.

See footnote at end of table.

TABLE 16.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Limitations for-- Embankments, dikes, and levees	Features affecting-- Drainage	Features affecting-- Irrigation	Features affecting-- Terraces and diversions	Features affecting-- Grassed waterways
Na: Nishna	Slight	Severe: hard to pack, wetness.	Flooding, percs slowly.	Slow intake, wetness, percs slowly.	Wetness, percs slowly, erodes easily.	Wetness, percs slowly, erodes easily.
Nb, Nf: Nodaway	Moderate: seepage.	Severe: piping.	Deep to water	Flooding, erodes easily.	Erodes easily	Erodes easily.
PaC: Pawnee	Moderate: slope.	Severe: hard to pack.	Percs slowly, frost action, slope.	Percs slowly, erodes easily.	Erodes easily, percs slowly.	Erodes easily.
PaD: Pawnee	Severe: slope.	Severe: hard to pack.	Percs slowly, frost action, slope.	Percs slowly, erodes easily.	Slope, erodes easily, percs slowly.	Slope, erodes easily.
PbC2: Pawnee	Moderate: slope.	Severe: hard to pack.	Percs slowly, frost action, slope.	Slow intake, percs slowly, erodes easily.	Erodes easily, percs slowly.	Erodes easily.
PbD2: Pawnee	Severe: slope.	Severe: hard to pack.	Percs slowly, frost action, slope.	Slow intake, percs slowly, erodes easily.	Slope, erodes easily, percs slowly.	Slope, erodes easily.
ShB: Sharpsburg	Moderate: seepage.	Slight	Deep to water	Favorable	Erodes easily	Erodes easily.
SkE, SkF: Shelby	Severe: slope.	Slight	Deep to water	Slope	Slope	Slope.
StF: Steinauer	Severe: slope.	Moderate: piping.	Deep to water	Slope	Slope	Slope.
Wc: Wabash	Slight	Severe: hard to pack, wetness.	Percs slowly, flooding.	Wetness, droughty, slow intake.	Wetness, percs slowly.	Wetness, droughty, percs slowly.
Wt: Wymore	Slight	Moderate: hard to pack, wetness.	Percs slowly, frost action.	Wetness, percs slowly.	Erodes easily, wetness.	Wetness, erodes easily.
WtC: Wymore	Moderate: slope.	Moderate: hard to pack, wetness.	Percs slowly, frost action, slope.	Wetness, percs slowly.	Erodes easily, wetness.	Wetness, erodes easily.
WyC2: Wymore	Moderate: slope.	Moderate: hard to pack, wetness.	Percs slowly, frost action, slope.	Wetness, slow intake, percs slowly.	Erodes easily, wetness.	Wetness, erodes easily.
Zh*:						
Zoe	Slight	Severe: wetness.	Percs slowly, flooding, frost action.	Wetness, percs slowly, flooding.	Wetness, percs slowly.	Wetness, percs slowly.
Zook	Slight	Severe: hard to pack, wetness.	Flooding, percs slowly, frost action.	Wetness, percs slowly.	Not needed	Not needed.
Zo: Zook	Slight	Severe: hard to pack, wetness.	Flooding, percs slowly, frost action.	Wetness, percs slowly.	Not needed	Not needed.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 17.--ENGINEERING INDEX PROPERTIES

[The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated]

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number-- 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
BrE2*:											
Burchard--------	0-5	Clay loam--------	CL	A-6, A-7	0-5	95-100	95-100	85-95	60-80	35-50	14-24
	5-25	Clay loam--------	CL	A-6, A-7	0-5	95-100	90-100	85-95	65-80	35-50	20-30
	25-60	Clay loam--------	CL	A-6, A-7	0-5	95-100	90-100	85-95	60-80	35-50	15-30
Steinauer-------	0-5	Clay loam--------	CL	A-6, A-7	0-5	95-100	95-100	85-100	55-90	30-50	15-25
	5-12	Clay loam--------	CL, CH	A-6, A-7	0-5	95-100	95-100	90-100	70-90	30-55	12-30
	12-60	Loam, clay loam	CL	A-6, A-7	0-5	95-100	95-100	90-100	60-75	20-45	10-26
DcD, DcF--------- Dickinson	0-18	Fine sandy loam	SM, SC, SM-SC	A-4, A-2	0	100	100	85-95	30-50	15-30	NP-10
	18-32	Fine sandy loam, sandy loam.	SM, SC, SM-SC	A-4	0	100	100	85-95	35-50	15-30	NP-10
	32-60	Loamy sand, loamy fine sand, fine sand.	SM, SP-SM, SM-SC	A-2, A-3	0	100	100	80-95	5-20	10-20	NP-5
JuC-------------- Judson	0-10	Silt loam--------	CL, CL-ML	A-6, A-7, A-4	0	100	100	100	95-100	25-50	5-25
	10-54	Silty clay loam	CL	A-6, A-7	0	100	100	100	95-100	30-50	15-25
	54-60	Silty clay loam, silt loam.	CL, CL-ML	A-6, A-7, A-4	0	100	100	100	95-100	25-50	5-25
Ke--------------- Kennebec	0-39	Silt loam--------	CL	A-6, A-7	0	100	100	95-100	90-100	25-45	10-20
	39-60	Silt loam, silty clay loam.	CL, CL-ML	A-4, A-6	0	100	100	95-100	90-100	25-40	5-15
KnB*:											
Kennebec--------	0-36	Silt loam--------	CL	A-6, A-7	0	100	100	95-100	72-100	25-45	10-20
	36-60	Silt loam, silty clay loam.	CL, CL-ML	A-4, A-6	0	100	100	95-100	90-100	25-40	5-15
Nodaway---------	0-60	Silt loam--------	CL, CL-ML	A-4, A-6	0	100	95-100	95-100	90-100	25-35	5-15
KpF*:											
Kipson----------	0-13	Flaggy silty clay loam.	CL-ML, CL	A-4, A-6	25-45	70-100	60-100	55-95	50-95	25-40	5-20
	13-18	Shaly silt loam, silt loam, silty clay loam.	CL-ML, CL	A-6, A-4	0-25	70-100	60-100	55-100	50-95	25-40	5-20
	18-60	Weathered bedrock	---	---	---	---	---	---	---	---	---
Benfield--------	0-10	Silty clay loam	CL	A-6, A-7	0-15	85-100	85-100	85-95	85-95	30-50	11-25
	10-36	Silty clay, silty clay loam, cherty silty clay.	CH, CL	A-7-6	0-15	85-100	70-100	70-95	70-95	40-60	20-35
	36-60	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
MaD, MaF--------- Malcolm	0-12	Silt loam--------	CL	A-4, A-6	0	100	100	90-100	70-90	25-35	7-17
	12-30	Silty clay loam, silt loam.	CL	A-6	0	100	100	90-100	70-95	25-40	10-20
	30-60	Silt loam, very fine sandy loam.	ML, CL, CL-ML	A-4, A-6	0	100	100	85-100	55-100	20-35	3-15

See footnote at end of table.

TABLE 17.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
MeC--------------- Mayberry	0-16	Clay loam--------	CL	A-6, A-7	0	100	95-100	90-100	75-100	35-45	15-25
	16-56	Clay, sandy clay	CL, CH	A-7	0	100	90-100	80-100	60-100	45-60	25-35
	56-75	Stratified sandy loam to clay.	CL, CH	A-6, A-7	0	95-100	95-100	85-95	70-95	35-60	15-30
MfC2-------------- Mayberry	0-5	Clay-------------	CH, CL	A-7	0	100	100	90-100	90-100	45-60	25-35
	5-43	Clay, sandy clay	CL, CH	A-7	0	100	90-100	80-100	60-100	45-60	25-35
	43-70	Stratified sandy loam to clay.	CL, CH	A-6, A-7	0	95-100	95-100	85-95	70-95	35-60	15-30
MrD--------------- Morrill	0-8	Clay loam--------	CL	A-4, A-6	0	95-100	80-100	70-100	50-82	25-36	7-16
	8-48	Clay loam, sandy clay loam, gravelly clay loam.	CL, SC	A-6, A-7-6	0	90-100	70-100	60-100	35-80	29-45	11-25
	48-60	Loam, clay loam, fine sandy loam.	CL, ML, SM, SC	A-4, A-6, A-2	0	90-100	70-100	60-100	30-80	20-35	2-16
MrD2-------------- Morrill	0-7	Clay loam--------	CL	A-4, A-6	0	95-100	80-100	70-100	50-82	25-36	7-16
	7-48	Clay loam, sandy clay loam, gravelly clay loam.	CL, SC	A-6, A-7-6	0	90-100	70-100	60-100	35-80	29-45	11-25
	48-60	Loam, clay loam, sandy loam.	CL, ML, SM, SC	A-4, A-6, A-2	0	90-100	70-100	60-100	30-80	20-35	2-15
Na---------------- Nishna	0-36	Silty clay-------	CH, MH	A-7	0	100	100	95-100	90-100	55-65	25-35
	36-70	Silty clay, silty clay loam.	CH	A-7	0	100	100	95-100	90-100	60-70	30-40
Nb, Nf------------ Nodaway	0-60	Silt loam--------	CL, CL-ML	A-4, A-6	0	100	95-100	95-100	72-100	25-35	5-15
PaC, PaD---------- Pawnee	0-12	Clay loam--------	CL	A-6	0	95-100	95-100	85-100	70-90	30-40	10-20
	12-42	Clay-------------	CH	A-7	0	95-100	95-100	85-100	70-85	50-70	25-45
	42-70	Clay loam, sandy clay loam.	CL, CH	A-7, A-6	0	95-100	95-100	80-100	70-90	35-55	20-40
PbC2, PbD2-------- Pawnee	0-7	Clay-------------	CH	A-7	0	95-100	95-100	85-100	70-85	50-70	25-45
	7-38	Clay-------------	CH	A-7	0	95-100	95-100	85-100	70-85	50-70	25-45
	38-60	Clay loam, sandy clay loam.	CL, CH	A-7, A-6	0	95-100	95-100	80-100	70-90	35-55	20-40
ShB--------------- Sharpsburg	0-11	Silty clay loam	CL, CH	A-7, A-6	0	100	100	100	95-100	35-55	18-32
	11-36	Silty clay loam, silty clay.	CH, CL	A-7	0	100	100	100	95-100	40-60	20-35
	36-57	Silty clay loam	CL	A-7, A-6	0	100	100	100	95-100	35-50	20-30
	57-70	Silty clay loam, silt loam.	CL	A-7, A-6	0	100	100	100	95-100	35-50	20-30
SkE, SkF---------- Shelby	0-15	Clay loam--------	CL	A-6, A-7	0	90-100	85-100	75-90	55-70	30-45	14-25
	15-51	Clay loam--------	CL	A-6, A-7	0-5	90-100	85-100	75-90	55-70	30-45	15-25
	51-70	Clay loam--------	CL	A-6, A-7	0-5	90-100	85-95	75-90	55-71	30-45	15-27
StF--------------- Steinauer	0-6	Clay loam--------	CL	A-6, A-7	0-5	95-100	95-100	85-100	55-90	30-50	15-25
	6-17	Clay loam--------	CL, CH	A-6, A-7	0-5	95-100	95-100	90-100	70-90	30-55	12-30
	17-60	Loam, clay loam	CL	A-6, A-7	0-5	95-100	95-100	90-100	60-75	20-45	10-26
Wc---------------- Wabash	0-8	Silty clay-------	CH	A-7	0	100	100	100	95-100	50-75	30-50
	8-60	Silty clay, clay	CH	A-7	0	100	100	100	95-100	52-78	30-55

See footnote at end of table.

TABLE 17.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
Wt, WtC----------- Wymore	0-10	Silty clay loam	CL, CH, ML, MH	A-6, A-7	0	100	100	95-100	95-100	35-55	11-25
	10-41	Silty clay--------	CH	A-7	0	100	100	95-100	95-100	55-70	30-42
	41-70	Silty clay loam	CL, CH	A-6, A-7	0	100	100	95-100	85-100	35-55	20-35
WyC2-------------- Wymore	0-8	Silty clay--------	CL, CH	A-7	0	100	100	95-100	95-100	45-55	15-30
	8-32	Silty clay--------	CH	A-7	0	100	100	95-100	95-100	55-70	30-42
	32-60	Silty clay loam	CL, CH	A-6, A-7	0	100	100	95-100	85-100	35-55	20-35
Zh*:											
Zoe--------------	0-12	Silty clay loam	CL	A-6, A-7, A-4	0	100	100	90-100	70-95	25-45	8-25
	12-32	Silty clay loam, silty clay.	CL, CH	A-6, A-7	0	100	100	95-100	85-95	35-60	15-35
	32-60	Silty clay--------	CH	A-7	0	100	100	95-100	90-95	50-70	25-40
Zook-------------	0-19	Silty clay loam	CH, CL	A-7, A-6	0	100	100	95-100	95-100	39-65	18-35
	19-60	Silty clay, silty clay loam.	CH	A-7	0	100	100	95-100	95-100	50-85	30-55
Zo--------------- Zook	0-22	Silty clay loam	CH, CL	A-7	0	100	100	95-100	95-100	45-65	20-35
	22-60	Silty clay, silty clay loam.	CH	A-7	0	100	100	95-100	95-100	60-85	35-55

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 18.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

[The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" and "Organic matter" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated]

Soil name and map symbol	Depth	Clay	Moist bulk density	Permea-bility	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors		Wind erodi-bility group	Organic matter
									K	T		
	In	Pct	g/cc	In/hr	In/in	pH	mmhos/cm					Pct
BrE2*:												
Burchard--------	0-5	27-35	1.40-1.60	0.2-0.6	0.17-0.19	5.6-7.3	<2	Moderate	0.28	5	6	2-4
	5-25	27-35	1.40-1.60	0.2-0.6	0.15-0.17	6.1-8.4	<2	Moderate	0.28			
	25-60	27-35	1.40-1.60	0.2-0.6	0.14-0.16	7.4-8.4	<2	Moderate	0.28			
Steinauer-------	0-5	27-32	1.30-1.60	0.2-0.6	0.17-0.19	7.4-8.4	<2	Moderate	0.32	5	4L	.5-2
	5-12	27-32	1.30-1.60	0.2-0.6	0.15-0.17	7.9-8.4	<2	Moderate	0.32			
	12-60	16-30	1.30-1.60	0.2-2.0	0.14-0.19	7.9-8.4	<2	Moderate	0.32			
DcD, DcF--------- Dickinson	0-18	12-18	1.50-1.55	2.0-6.0	0.12-0.15	5.6-7.3	<2	Low--------	0.20	4	3	1-2
	18-32	10-15	1.45-1.55	2.0-6.0	0.12-0.15	5.1-6.5	<2	Low--------	0.20			
	32-60	5-10	1.55-1.65	6.0-20	0.08-0.10	5.1-6.5	<2	Low--------	0.20			
JuC-------------- Judson	0-10	25-32	1.30-1.35	0.6-2.0	0.21-0.23	5.6-7.3	<2	Moderate	0.28	5	6	4-5
	10-54	30-35	1.35-1.45	0.6-2.0	0.21-0.23	5.6-7.3	<2	Moderate	0.43			
	54-60	25-32	1.35-1.45	0.6-2.0	0.21-0.23	6.1-7.8	<2	Moderate	0.43			
Ke--------------- Kennebec	0-39	26-30	1.25-1.35	0.6-2.0	0.22-0.24	5.6-7.3	<2	Moderate	0.32	5	6	5-6
	39-60	24-35	1.35-1.40	0.6-2.0	0.20-0.22	6.1-7.3	<2	Moderate	0.43			
KnB*:												
Kennebec--------	0-36	26-30	1.25-1.35	0.6-2.0	0.22-0.24	5.6-7.3	<2	Moderate	0.32	5	6	5-6
	36-60	24-35	1.35-1.40	0.6-2.0	0.20-0.22	6.1-7.3	<2	Moderate	0.43			
Nodaway---------	0-60	18-28	1.25-1.35	0.6-2.0	0.20-0.23	6.1-7.3	<2	Moderate	0.37	5	6	2-3
KpF*:												
Kipson----------	0-13	18-35	1.30-1.40	0.6-2.0	0.12-0.18	7.4-8.4	<2	Low--------	0.24	2	8	2-4
	13-18	18-35	1.35-1.50	0.6-2.0	0.15-0.20	7.9-9.0	<2	Moderate	0.32			
	18-60	---	---	---	---	---	---	----------	----			
Benfield--------	0-10	20-35	1.30-1.40	0.2-2.0	0.21-0.24	6.1-7.8	<2	Moderate	0.37	3	7	2-4
	10-36	35-45	1.35-1.45	0.06-0.2	0.18-0.22	6.6-8.4	<2	High------	0.37			
	36-60	---	---	---	---	---	---	----------	----			
MaD, MaF--------- Malcolm	0-12	17-23	1.20-1.30	0.6-2.0	0.22-0.24	5.6-6.5	<2	Low--------	0.32	5	5	2-3
	12-30	24-35	1.30-1.40	0.6-2.0	0.18-0.22	5.6-6.5	<2	Moderate	0.43			
	30-60	12-23	1.20-1.30	0.6-2.0	0.17-0.22	5.6-6.5	<2	Low--------	0.43			
MeC-------------- Mayberry	0-16	27-40	1.40-1.50	0.2-0.6	0.17-0.23	5.6-6.5	<2	Moderate	0.37	4	6	3-4
	16-56	40-50	1.50-1.70	0.06-0.2	0.10-0.11	5.6-7.8	<2	High------	0.37			
	56-75	18-45	1.40-1.50	0.06-0.2	0.09-0.16	6.1-8.4	<2	Moderate	0.37			
MfC2------------- Mayberry	0-5	40-46	1.40-1.50	0.06-0.2	0.12-0.14	5.6-6.5	<2	High------	0.37	3	4	2-3
	5-43	40-50	1.50-1.70	0.06-0.2	0.10-0.11	5.6-7.8	<2	High------	0.37			
	43-70	18-45	1.40-1.50	0.06-0.2	0.09-0.16	6.1-8.4	<2	Moderate	0.37			
MrD-------------- Morrill	0-8	15-29	1.30-1.40	0.6-2.0	0.14-0.21	5.1-7.3	<2	Low--------	0.28	5	6	3-4
	8-48	25-35	1.35-1.45	0.6-2.0	0.15-0.19	5.1-7.3	<2	Moderate	0.28			
	48-60	10-29	1.40-1.55	0.6-2.0	0.15-0.18	5.1-7.3	<2	Low--------	0.37			
MrD2------------- Morrill	0-7	15-29	1.30-1.40	0.6-2.0	0.14-0.21	5.1-7.3	<2	Low--------	0.28	5	6	2-3
	7-48	25-35	1.35-1.45	0.6-2.0	0.15-0.19	5.1-7.3	<2	Moderate	0.28			
	48-60	10-29	1.40-1.55	0.6-2.0	0.15-0.18	5.1-7.3	<2	Low--------	0.37			

See footnote at end of table.

TABLE 18.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permea- bility	Available water capacity	Soil reaction	Salinity	Shrink- swell potential	Erosion factors K	Erosion factors T	Wind erodi- bility group	Organic matter
	In	Pct	g/cc	In/hr	In/in	pH	mmhos/cm					Pct
Na------------- Nishna	0-36	36-44	1.30-1.35	0.06-0.2	0.12-0.14	7.4-8.4	<2	High------	0.37	5	4	4-6
	36-70	38-46	1.35-1.40	0.06-0.2	0.11-0.13	7.4-8.4	<2	High------	0.28			
Nb, Nf----------- Nodaway	0-60	18-28	1.25-1.35	0.6-2.0	0.20-0.23	6.1-7.3	<2	Moderate	0.37	5	6	2-3
PaC, PaD--------- Pawnee	0-12	30-38	1.40-1.50	0.2-0.6	0.17-0.19	5.6-7.3	<2	Moderate	0.37	4	6	3-4
	12-42	40-50	1.50-1.70	0.06-0.2	0.09-0.11	6.1-8.4	<2	High------	0.37			
	42-70	25-35	1.40-1.50	0.06-0.2	0.14-0.16	7.4-8.4	<2	High------	0.37			
PbC2, PbD2------- Pawnee	0-7	40-46	1.40-1.50	0.06-0.2	0.09-0.11	5.6-7.3	<2	High------	0.37	3	4	2-3
	7-38	40-50	1.50-1.70	0.06-0.2	0.09-0.11	6.1-8.4	<2	High------	0.37			
	38-60	25-35	1.40-1.50	0.06-0.2	0.14-0.16	7.4-8.4	<2	High------	0.37			
ShB-------------- Sharpsburg	0-11	27-34	1.30-1.35	0.6-2.0	0.21-0.23	5.1-6.5	<2	Moderate	0.32	5	7	3-4
	11-36	36-42	1.35-1.40	0.2-0.6	0.18-0.20	5.1-6.0	<2	Moderate	0.43			
	36-57	30-38	1.40-1.45	0.6-2.0	0.18-0.20	5.1-6.5	<2	Moderate	0.43			
	57-70	25-32	1.40-1.45	0.6-2.0	0.18-0.20	6.1-6.5	<2	Moderate	0.43			
SkE, SkF--------- Shelby	0-15	27-35	1.50-1.55	0.2-0.6	0.16-0.18	5.1-7.3	<2	Moderate	0.28	4	6	3-4
	15-51	30-35	1.55-1.75	0.2-0.6	0.16-0.18	5.1-7.3	<2	Moderate	0.28			
	51-70	30-35	1.75-1.85	0.2-0.6	0.16-0.18	6.6-8.4	<2	Moderate	0.37			
StF-------------- Steinauer	0-6	27-32	1.30-1.60	0.2-0.6	0.17-0.19	7.4-8.4	<2	Moderate	0.32	5	4L	.5-2
	6-17	27-32	1.30-1.60	0.2-0.6	0.15-0.17	7.9-8.4	<2	Moderate	0.32			
	17-60	16-30	1.30-1.60	0.2-2.0	0.14-0.19	7.9-8.4	<2	Moderate	0.32			
Wc--------------- Wabash	0-8	40-46	1.25-1.45	<0.06	0.12-0.14	5.6-7.3	<2	Very high	0.28	5	4	2-4
	8-60	40-60	1.20-1.45	<0.06	0.08-0.12	5.6-7.8	<2	Very high	0.28			
Wt, WtC---------- Wymore	0-10	30-40	1.15-1.20	0.2-0.6	0.21-0.23	5.6-6.5	<2	Moderate	0.37	4	4	2-4
	10-41	42-55	1.10-1.20	0.06-0.2	0.11-0.14	5.6-7.3	<2	High------	0.37			
	41-70	27-40	1.15-1.25	0.2-0.6	0.18-0.20	6.6-7.3	<2	High------	0.37			
WyC2------------- Wymore	0-8	40-45	1.15-1.20	0.2-0.6	0.21-0.23	5.6-6.5	<2	High------	0.37	4	4	2-3
	8-32	42-55	1.10-1.20	0.06-0.2	0.11-0.14	5.6-7.3	<2	High------	0.37			
	32-60	27-40	1.15-1.25	0.2-0.6	0.18-0.20	6.6-7.3	<2	High------	0.37			
Zh*:												
Zoe--------------	0-12	34-40	1.10-1.30	0.2-0.6	0.17-0.23	6.1-7.8	<4	Moderate	0.32	5	4	2-3
	12-32	36-45	1.20-1.30	0.06-0.6	0.11-0.20	6.1-7.8	4-8	High------	0.32			
	32-60	40-50	1.20-1.30	0.06-0.2	0.10-0.13	7.4-9.0	2-4	High------	0.32			
Zook-------------	0-19	32-38	1.30-1.35	0.2-0.6	0.21-0.23	5.6-7.3	<2	High------	0.28	5	7	5-7
	19-60	36-45	1.30-1.45	0.06-0.2	0.11-0.13	5.6-7.8	<2	High------	0.28			
Zo--------------- Zook	0-22	32-38	1.30-1.35	0.2-0.6	0.21-0.23	5.6-7.3	<2	High------	0.28	5	7	5-7
	22-60	36-45	1.30-1.45	0.06-0.2	0.11-0.13	5.6-7.8	<2	High------	0.28			

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 19.--SOIL AND WATER FEATURES

["Flooding" and "water table" and terms such as "rare," "brief," "apparent," and "perched" are explained in the text. The symbol < means less than; > means more than. Absence of an entry indicates that the feature is not a concern or that data were not estimated]

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
BrE2*:												
Burchard	B	None	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Low.
Steinauer	B	None	---	---	>6.0	---	---	>60	---	Moderate	High	Low.
DcD, DcF Dickinson	B	None	---	---	>6.0	---	---	>60	---	Moderate	Low	Moderate.
JuC Judson	B	None	---	---	>6.0	---	---	>60	---	High	Moderate	Low.
Ke Kennebec	B	Rare	---	---	4.0-6.0	Apparent	Nov-Jul	>60	---	High	Moderate	Low.
KnB*:												
Kennebec	B	Rare	---	---	4.0-6.0	Apparent	Nov-Jul	>60	---	High	Moderate	Low.
Nodaway	B	Occasional	Very brief to brief.	Feb-Nov	3.0-5.0	Apparent	Apr-Jul	>60	---	High	Moderate	Low.
KpF*:												
Kipson	D	None	---	---	>6.0	---	---	7-20	Soft	Moderate	Low	Low.
Benfield	C	None	---	---	>6.0	---	---	20-40	Soft	Moderate	High	Low.
MaD, MaF Malcolm	B	None	---	---	>6.0	---	---	>60	---	High	Moderate	Moderate.
MeC, MfC2 Mayberry	D	None	---	---	1.0-3.0	Perched	Mar-May	>60	---	High	High	Low.
MrD, MrD2 Morrill	B	None	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Moderate.
Na Nishna	C/D	Occasional	Brief	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	>60	---	Moderate	High	Low.
Nb Nodaway	B	Occasional	Very brief to brief.	Feb-Nov	3.0-5.0	Apparent	Apr-Jul	>60	---	High	Moderate	Low.
Nf Nodaway	B	Frequent	Very brief to brief.	Feb-Nov	3.0-5.0	Apparent	Apr-Jul	>60	---	High	Moderate	Low.

See footnote at end of table.

TABLE 19.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
PaC, PaD, PbC2, PbD2 Pawnee	D	None	---	---	1.0-3.0	Perched	Mar-May	>60	---	High	High	Low.
ShB Sharpsburg	B	None	---	---	>6.0	---	---	>60	---	High	Moderate	Moderate.
SkE, SkF Shelby	B	None	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Moderate.
StF Steinauer	B	None	---	---	>6.0	---	---	>60	---	Moderate	High	Low.
Wc Wabash	D	Occasional	Brief to long.	Nov-May	0-1.0	Apparent	Nov-May	>60	---	Moderate	High	Moderate.
Wt, WtC, WyC2 Wymore	D	None	---	---	1.0-3.0	Perched	Mar-Apr	>60	---	High	High	Moderate.
Zh*:												
Zoe	D	Occasional	Brief	Mar-Jun	1.0-3.0	Apparent	Nov-May	>60	---	High	High	High.
Zook	C/D	Occasional	Brief to long.	Feb-Nov	1.0-3.0	Apparent	Nov-May	>60	---	High	High	Moderate.
Zo Zook	C/D	Occasional	Brief to long.	Feb-Nov	1.0-3.0	Apparent	Nov-May	>60	---	High	High	Moderate.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 20.--ENGINEERING INDEX TEST DATA

[Dashes indicate data were not available. LL means liquid limit and PI, plasticity index]

Soil name*, report number, horizon, and depth in inches	Classification		Grain-size distribution									LL	PI	Specific gravity
			Percentage passing sieve--						Percentage smaller than--					
	AASHTO	Unified	3/4 inch	3/8 inch	No. 4	No. 10	No. 40	No. 200	.05 mm	.005 mm	.002 mm**			
												Pct		g/cc
Morrill clay loam: (S81NE-097-4)														
Ap----- 0 to 8	A-6(10)	CL	---	---	---	100	99	82	72	29	23	36	16	2.63
Bt2---- 18 to 29	A-6(10)	CL	---	---	---	100	99	67	64	34	28	37	19	2.66
C------ 48 to 60	A-6(1)	SC	---	---	---	100	99	38	29	20	16	29	11	2.66
Nodaway silt loam: (S81NE-097-5)														
Ap----- 0 to 7	A-4(7)	CL	---	---	---	100	99	72	65	18	14	26	7	2.62
C------ 7 to 32	A-6(8)	CL	---	---	---	---	100	97	91	22	17	33	11	2.64
Pawnee clay: (S81NE-097-8)														
Bt1---- 7 to 23	A-7-6 (24)	CL	99	97	97	96	92	78	75	48	41	60	39	2.69
C------ 38 to 60	A-7-6 (18)	CL, CH	98	97	97	96	92	74	70	39	32	50	31	2.71
Shelby clay loam: (S81NE-097-6)														
Ap----- 0 to 7	A-6(7)	CL	99	98	98	97	89	63	57	30	22	34	14	2.64
Bt2---- 18 to 27	A-7-6 (12)	CL	---	100	99	97	90	69	65	33	24	43	22	2.68
C------ 36 to 60	A-7-6 (15)	CL	---	100	98	95	88	71	68	39	30	45	27	2.71
Wymore silty clay: (S81NE-097-9)														
Ap----- 0 to 8	A-7-6 (19)	CH	---	---	---	---	100	99	95	48	41	54	30	2.64
Bt1---- 8 to 17	A-7-6 (21)	CH	---	---	---	---	100	99	97	53	42	57	35	2.68
C------ 32 to 60	A-7-6 (16)	CL	---	---	---	---	100	100	98	36	26	47	26	2.71

See footnotes at end of table.

TABLE 20.--ENGINEERING INDEX TEST DATA--Continued

Soil name*, report number, horizon, and depth in inches	Classification		Grain-size distribution									LL	PI	Specific gravity
			Percentage passing sieve--						Percentage smaller than--					
	AASHTO	Unified	3/4 inch	3/8 inch	No. 4	No. 10	No. 40	No. 200	.05 mm	.005 mm	.002 mm**			
												Pct		g/cc
Zook silty clay loam: (S81NE-097-7)														
A------ 8 to 22	A-6(11)	CL	---	---	---	---	100	98	96	37	28	39	18	2.61
Bg----- 22 to 60	A-7-6 (25)	CH	---	---	---	---	100	99	98	55	46	64	41	2.66
C------ 60 to 75	A-7-6 (20)	CH	---	---	---	---	100	99	96	46	33	53	33	2.65

* Locations of the sampled pedons are as follows--

Morrill clay loam: 150 feet east and 125 feet south of the northwest corner of sec. 13, T. 6 N., R. 11 E.

Nodaway silt loam: 1,775 feet east and 325 feet north of the southwest corner of sec. 17, T. 6 N., R. 12 E.

Pawnee clay: 1,575 feet west and 225 feet north of the southeast corner of sec. 4, T. 4 N., R. 10 E.

Shelby clay loam: 1,475 feet south and 75 feet east of the northwest corner of sec. 17, T. 5 N., R. 10 E.

Wymore silty clay: 1,150 feet east and 325 feet south of the northwest corner of sec. 30, T. 5 N., R. 10 E.

Zook silty clay loam: 2,450 feet east and 125 feet south of the northwest corner of sec. 36, T. 4 N., R. 11 E.

** The results obtained by engineering test analyses may differ from those obtained by USDA analyses of texture because different procedures were used.

TABLE 21.--CLASSIFICATION OF THE SOILS

[An asterisk in the first column indicates that the soil is a taxadjunct to the series. See text for a description of those characteristics of the soil that are outside the range of the series]

Soil name	Family or higher taxonomic class
*Benfield	Fine, mixed, mesic Udic Argiustolls
Burchard	Fine-loamy, mixed, mesic Typic Argiudolls
Dickinson	Coarse-loamy, mixed, mesic Typic Hapludolls
Judson	Fine-silty, mixed, mesic Cumulic Hapludolls
Kennebec	Fine-silty, mixed, mesic Cumulic Hapludolls
*Kipson	Loamy, mixed, mesic, shallow Udorthentic Haplustolls
Malcolm	Fine-silty, mixed, mesic Typic Argiudolls
Mayberry	Fine, montmorillonitic, mesic Aquic Argiudolls
Morrill	Fine-loamy, mixed, mesic Typic Argiudolls
Nishna	Fine, montmorillonitic (calcareous), mesic Cumulic Haplaquolls
Nodaway	Fine-silty, mixed, nonacid, mesic Mollic Udifluvents
Pawnee	Fine, montmorillonitic, mesic Aquic Argiudolls
Sharpsburg	Fine, montmorillonitic, mesic Typic Argiudolls
Shelby	Fine-loamy, mixed, mesic Typic Argiudolls
Steinauer	Fine-loamy, mixed (calcareous), mesic Typic Udorthents
Wabash	Fine, montmorillonitic, mesic Vertic Haplaquolls
Wymore	Fine, montmorillonitic, mesic Aquic Argiudolls
Zoe	Fine, montmorillonitic, mesic Cumulic Haplaquolls
Zook	Fine, montmorillonitic, mesic Cumulic Haplaquolls

Interpretive Groups

INTERPRETIVE GROUPS

[Dashes indicate that the soil was not placed in the interpretive group]

Soil name and map symbol	Land capability* N	Land capability* I	Prime farmland*	Range site	Windbreak suitability group
BrE2	IVe	IVe	---		
Burchard				Silty	3
Steinauer				Limy Upland	8
DcD	IVe	IVe	---	Sandy	5
Dickinson					
DcF	VIe	---	---	Sandy	5
Dickinson					
JuC	IIe	IIIe	Yes	Silty	3
Judson					
Ke	I	I	Yes	Silty Lowland	1
Kennebec					
KnB	IIw	IIw	Yes		
Kennebec				Silty Lowland	1
Nodaway				Silty Overflow	1
KpF	VIs	---	---		
Kipson				Shallow Limy	10
Benfield				Clayey	10
MaD	IVe	IVe	---	Silty	3
Malcolm					
MaF	VIe	---	---	Silty	3
Malcolm					
MeC	IIIe	IVe	---	Clayey	4C
Mayberry					
MfC2	IVe	IVe	---	Dense Clay	4C
Mayberry					
MrD	IIIe	IVe	---	Silty	3
Morrill					
MrD2	IVe	IVe	---	Silty	3
Morrill					
Na	IIIw	IIIw	Yes**	Clayey Overflow	2W
Nishna					
Nb	IIw	IIw	Yes	Silty Overflow	1
Nodaway					
Nf	VIw	---	---	Silty Overflow	10
Nodaway					
PaC	IIIe	IVe	---	Clayey	4C
Pawnee					
PaD	IVe	---	---	Clayey	4C
Pawnee					
PbC2	IVe	IVe	---	Dense Clay	4C
Pawnee					
PbD2	VIe	---	---	Dense Clay	4C
Pawnee					

INTERPRETIVE GROUPS--Continued

Soil name and map symbol	Land capability* N	Land capability* I	Prime farmland*	Range site	Windbreak suitability group
ShB------------------------- Sharpsburg	IIe	IIIe	Yes	Silty----------------	3
SkE------------------------- Shelby	IVe	IVe	---	Silty----------------	3
SkF------------------------- Shelby	VIe	---	---	Silty----------------	10
StF------------------------- Steinauer	VIe	---	---	Limy Upland----------	8
Wc-------------------------- Wabash	IIIw	IIIw	---	Clayey Overflow------	2W
Wt-------------------------- Wymore	IIs	IIs	Yes	Clayey---------------	4L
WtC------------------------- Wymore	IIIe	IIIe	Yes	Clayey---------------	4L
WyC2------------------------ Wymore	IIIe	IVe	Yes	Clayey---------------	4L
Zh--------------------------	IVs	IVs	---		
Zoe-------------------------				Saline Subirrigated--	9S
Zook------------------------				Clayey Overflow------	2W
Zo-------------------------- Zook	IIw	IIw	Yes**	Clayey Overflow------	2W

* A soil complex is treated as a single management unit in the land capability classification and prime farmland columns. The N column is for nonirrigated soils; the I column is for irrigated soils.

** Where drained.

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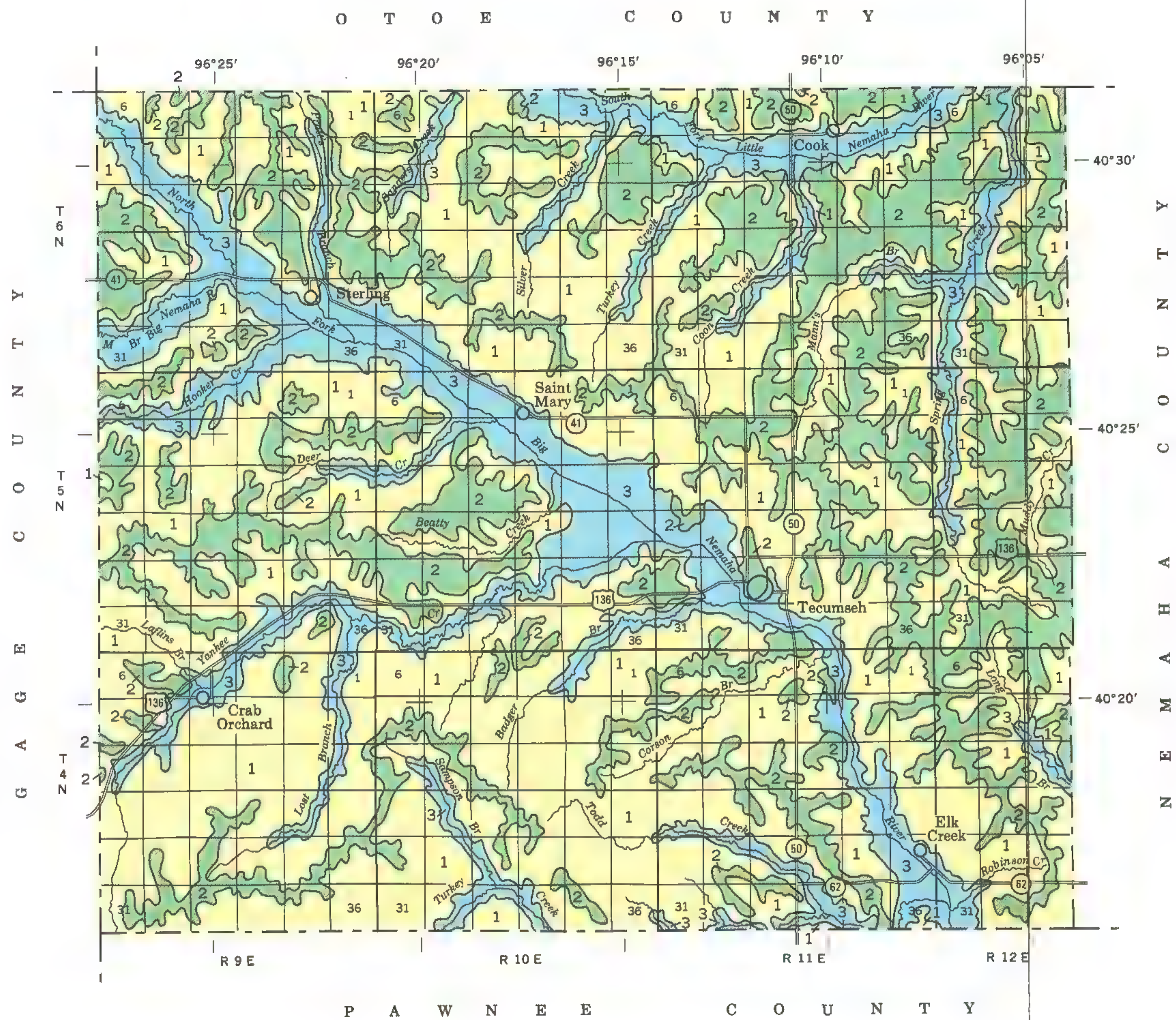


LEGEND*

1	PAWNEE-MORRILL-SHELBY association: Deep, gently sloping to steep, moderately well drained and well drained, clayey and loamy soils that formed in glacial material; on uplands
2	WYMORE association: Deep, nearly level and gently sloping, moderately well drained, clayey and silty soils that formed in loess; on uplands
3	NODAWAY-ZOOK-JUDSON association: Deep, nearly level and gently sloping, moderately well drained, poorly drained, and well drained, silty soils that formed in alluvium and colluvium; on bottom lands, foot slopes, and stream terraces

*The texture given in the descriptive headings refers to the surface layer of the major soils in the associations.

N

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
UNIVERSITY OF NEBRASKA, CONSERVATION AND SURVEY DIVISION

GENERAL SOIL MAP

JOHNSON COUNTY, NEBRASKA

Scale 1:190,080

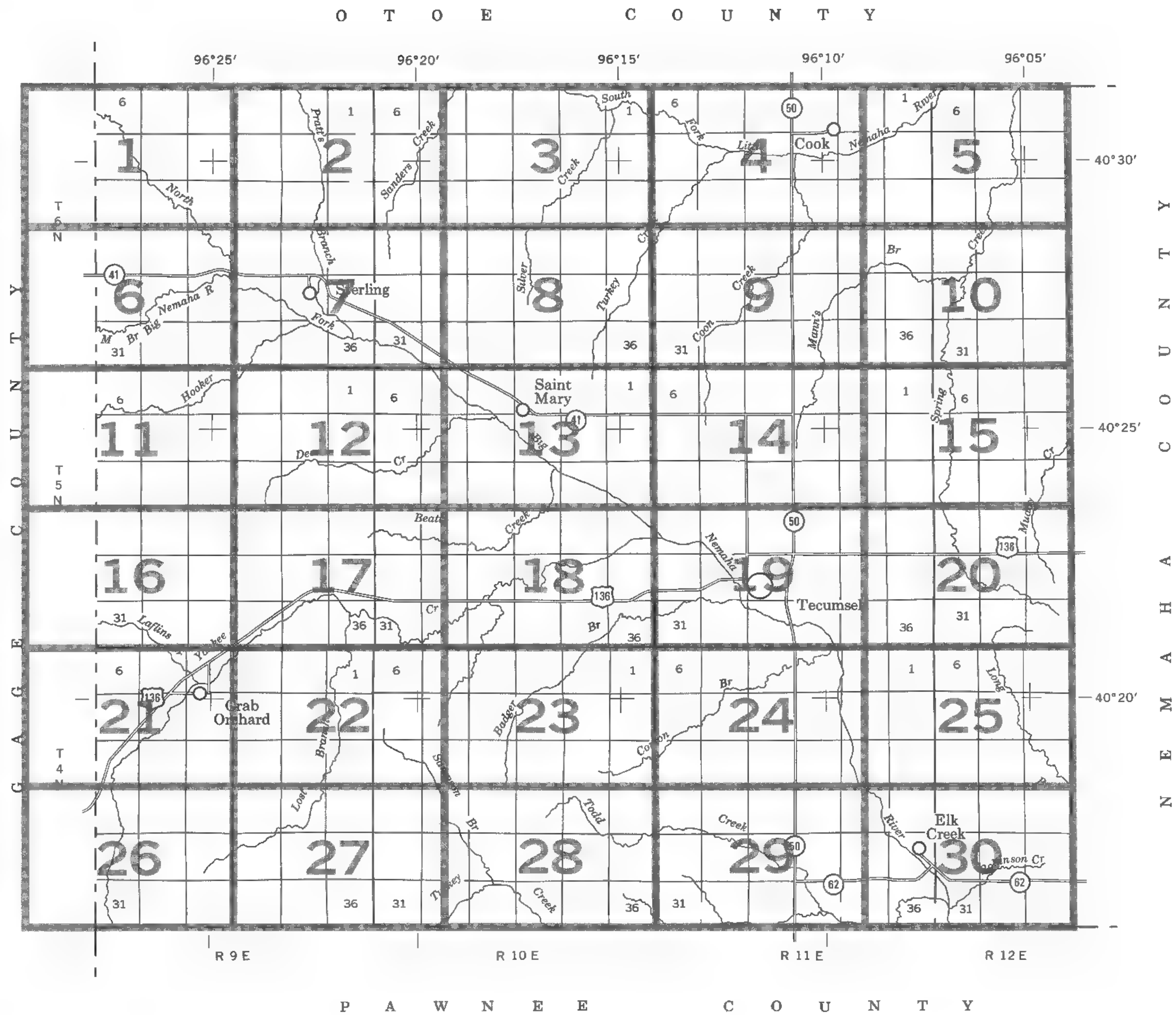
1 0 1 2 3 Miles

1 0 3 6 Km

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.



SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

INDEX TO MAP SHEETS

JOHNSON COUNTY, NEBRASKA

Scale 1:190,080

1 0 1 2 3 Miles

1 0 3 6 Km

SOIL LEGEND

Map symbols consist of a combination of letters or of letters and a number. The first capital letter is the initial one of the map unit name. The lowercase letter that follows separates map units having names that begin with the same letter, except that it does not separate sloping or eroded phases. The second capital letter indicates the class of slope. Symbols without a slope letter are for nearly level soils. A final number of 2 indicates that the soil is eroded.

SYMBOL	NAME
BrE2	Burchard-Steinauer clay loams, 9 to 15 percent slopes, eroded
DcD	Dickinson fine sandy loam, 6 to 11 percent slopes
DcF	Dickinson fine sandy loam, 11 to 20 percent slopes
JuC	Judson silt loam, 2 to 6 percent slopes
Ke	Kennebec silt loam, 0 to 1 percent slopes
KnB	Kennebec-Nodaway silt loams, 0 to 4 percent slopes
KpF	Kipson-Benfield complex, 11 to 25 percent slopes
MaD	Malcolm silt loam, 5 to 11 percent slopes
MaF	Malcolm silt loam, 11 to 25 percent slopes
MeC	Mayberry clay loam, 3 to 9 percent slopes
MfC2	Mayberry clay, 3 to 9 percent slopes, eroded
MrD	Morrill clay loam, 5 to 11 percent slopes
MrD2	Morrill clay loam, 5 to 11 percent slopes, eroded
Na	Nishna silty clay, 0 to 1 percent slopes
Nb	Nodaway silt loam, 0 to 1 percent slopes
Nf	Nodaway silt loam, channeled
PaC	Pawnee clay loam, 3 to 9 percent slopes
PaD	Pawnee clay loam, 9 to 12 percent slopes
PbC2	Pawnee clay, 3 to 9 percent slopes, eroded
PbD2	Pawnee clay, 9 to 12 percent slopes, eroded
ShB	Sharpsburg silty clay loam, 1 to 4 percent slopes
SkE	Shelby clay loam, 9 to 15 percent slopes
SkF	Shelby clay loam, 15 to 30 percent slopes
StF	Steinauer clay loam, 15 to 20 percent slopes
Wc	Wabash silty clay, 0 to 1 percent slopes
Wt	Wymore silty clay loam, 0 to 2 percent slopes
WtC	Wymore silty clay loam, 2 to 7 percent slopes
WyC2	Wymore silty clay, 2 to 7 percent slopes, eroded
Zh	Zoe-Zook silty clay loams, 0 to 1 percent slopes
Zo	Zook silty clay loam, 0 to 1 percent slopes

CONVENTIONAL AND SPECIAL SYMBOLS LEGEND

CULTURAL FEATURES

BOUNDARIES

- County
- Reservation (national forest or park, state forest or park, and large airport)
- Field sheet matchline & neatline

AD HOC BOUNDARY (label)

- Small airport, airfield, park, cemetery, or flood pool — Davis Airstrip; FLOOD POOL LINE

STATE COORDINATE TICK

LAND DIVISION CORNERS (sections and land grants)

ROADS

- Other roads
- Trail

ROAD EMBLEMS & DESIGNATIONS

- Federal — 410
- State — 52
- County, farm or ranch — 378

RAILROAD

DAMS

- Large (to scale)
- Medium or small — water; w

PITS

- Gravel pit

MISCELLANEOUS CULTURAL FEATURES

- Farmstead, house (omit in urban areas)
- Church
- School
- Located object (label) — Tower

WATER FEATURES

DRAINAGE

- Perennial, double line
- Perennial, single line
- Intermittent
- Drainage end

LAKES, PONDS AND RESERVOIRS

- Perennial — water; w
- Intermittent — int; i

MISCELLANEOUS WATER FEATURES

- Well, artesian
- Well, irrigation
- Wet spot

SPECIAL SYMBOLS FOR SOIL SURVEY

SOIL DELINEATIONS AND SYMBOLS — PaC; WyC2

- Other than bedrock (points down slope)

SHORT STEEP SLOPE

GULLY

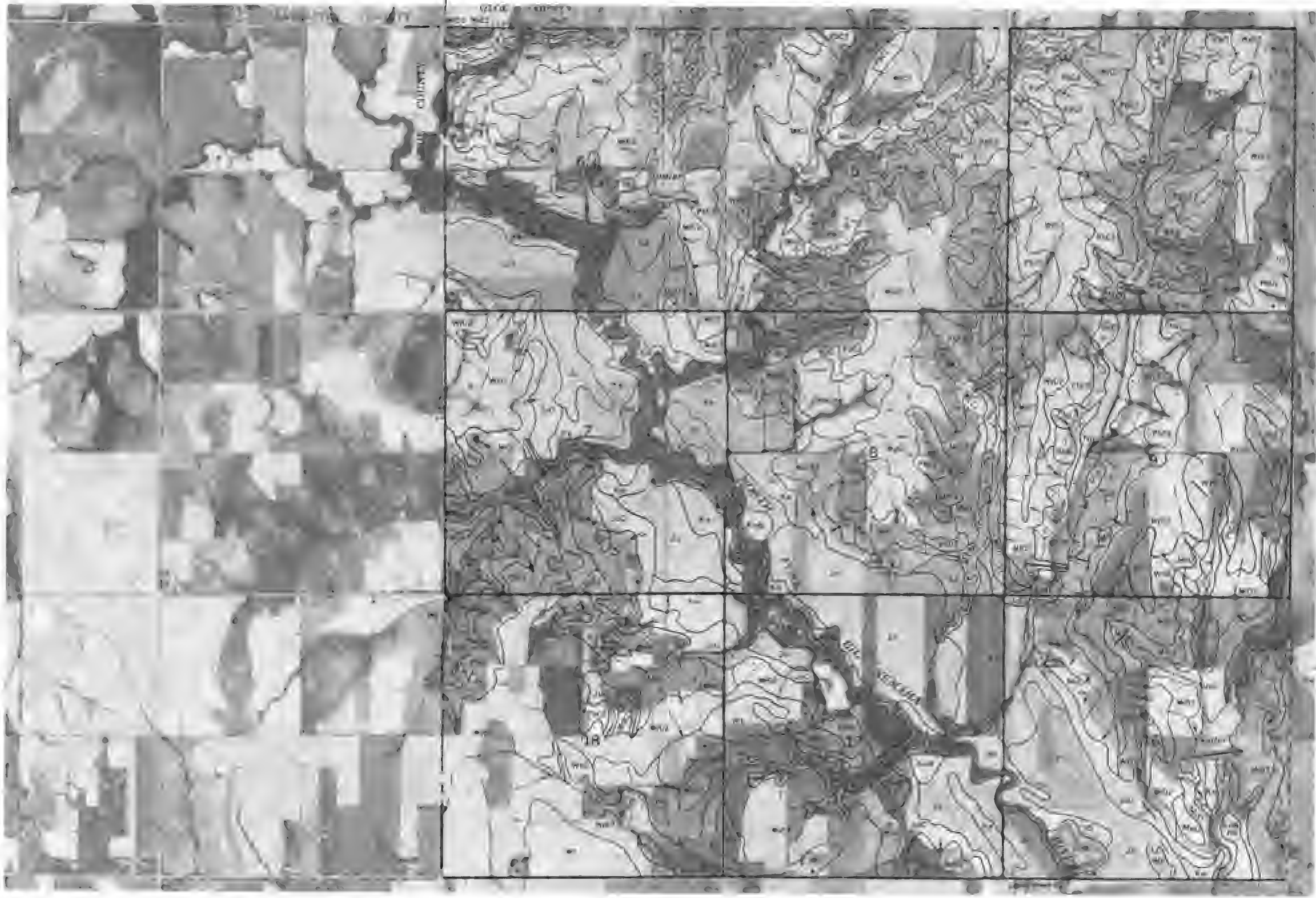
DEPRESSION

MISCELLANEOUS

- Gravelly spot (up to 3 acres)
- Gumbo, slick or scabby spot (sodic) (up to 3 acres)
- Rock outcrop (includes sandstone and shale) (up to 3 acres)
- Sandy spot (up to 5 acres)
- Severely eroded spot (up to 5 acres)
- Stony spot, very stony spot (up to 3 acres)
- Glacial till spot (up to 5 acres) — #

JOHNSON COUNTY, NEBRASKA — SHEET NUMBER 1

1



N

Scale 1:20000

5000 Feet 0 1000 2000 3000 4000 5000

This map is compiled on 1974 aerial photography by the U. S. Department Service and cooperating agencies.
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1 Mile

5000 Feet

Scale 1:20000

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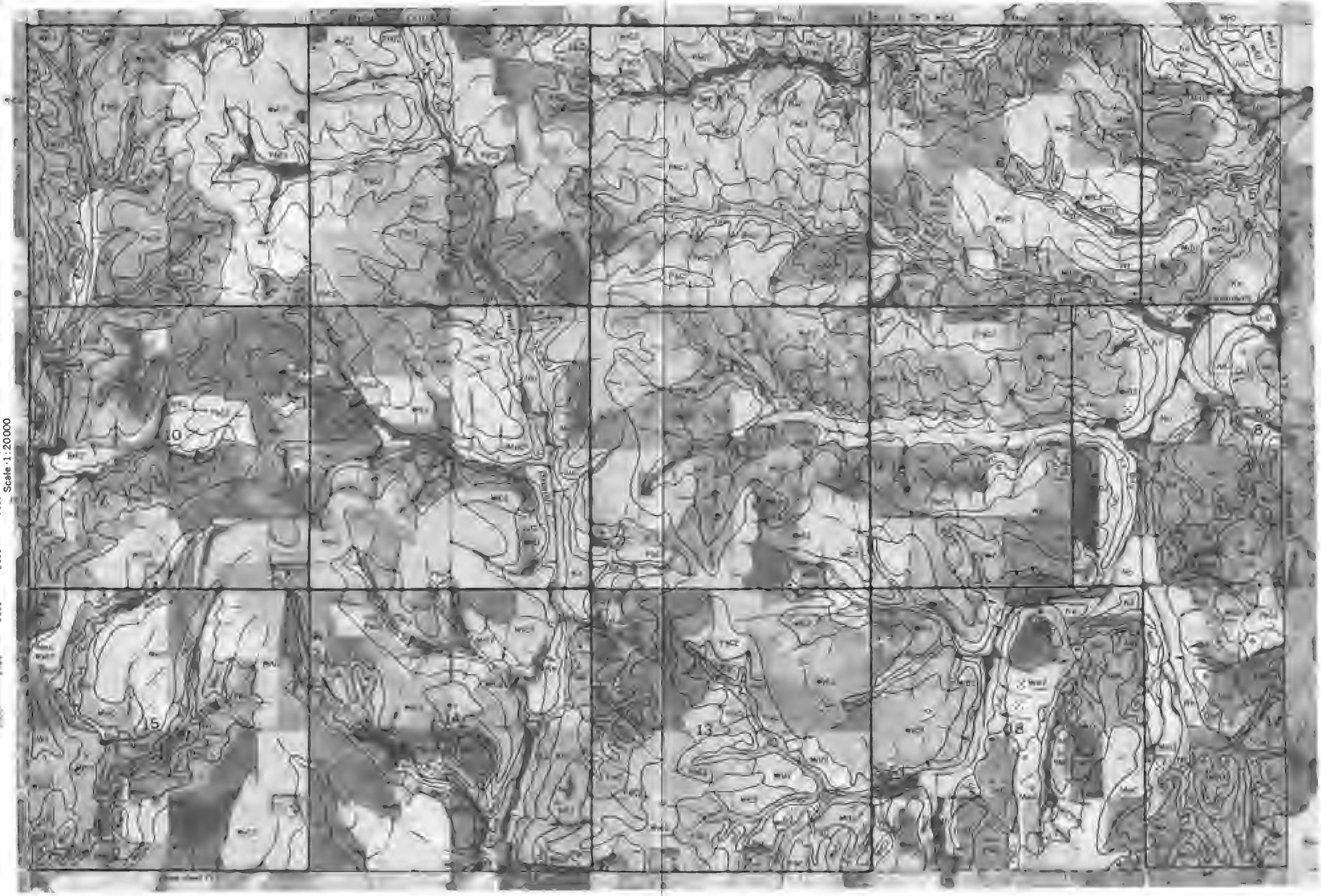

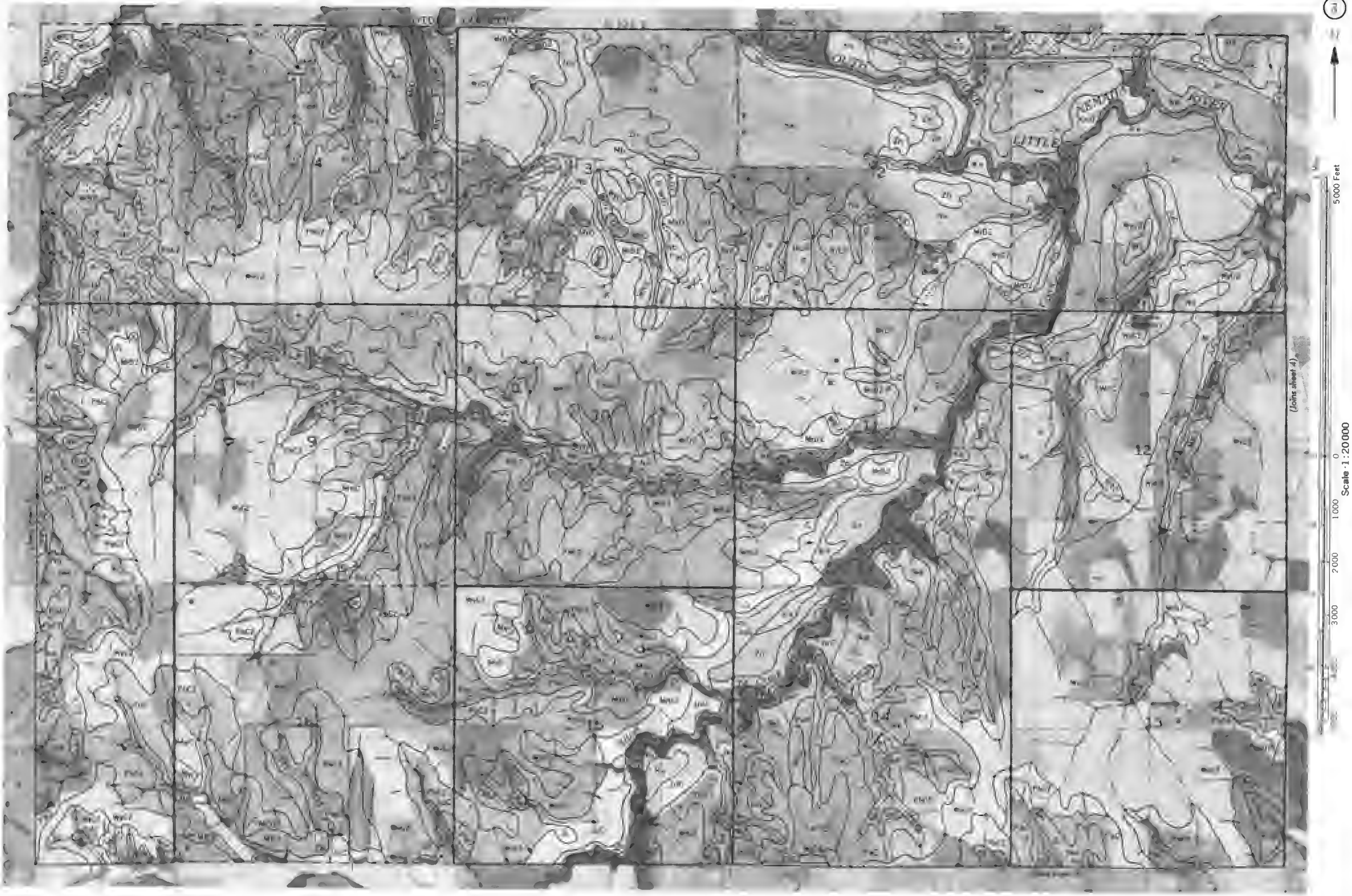

LITTLE NEMAHA RIVER
(Joins sheet 4)
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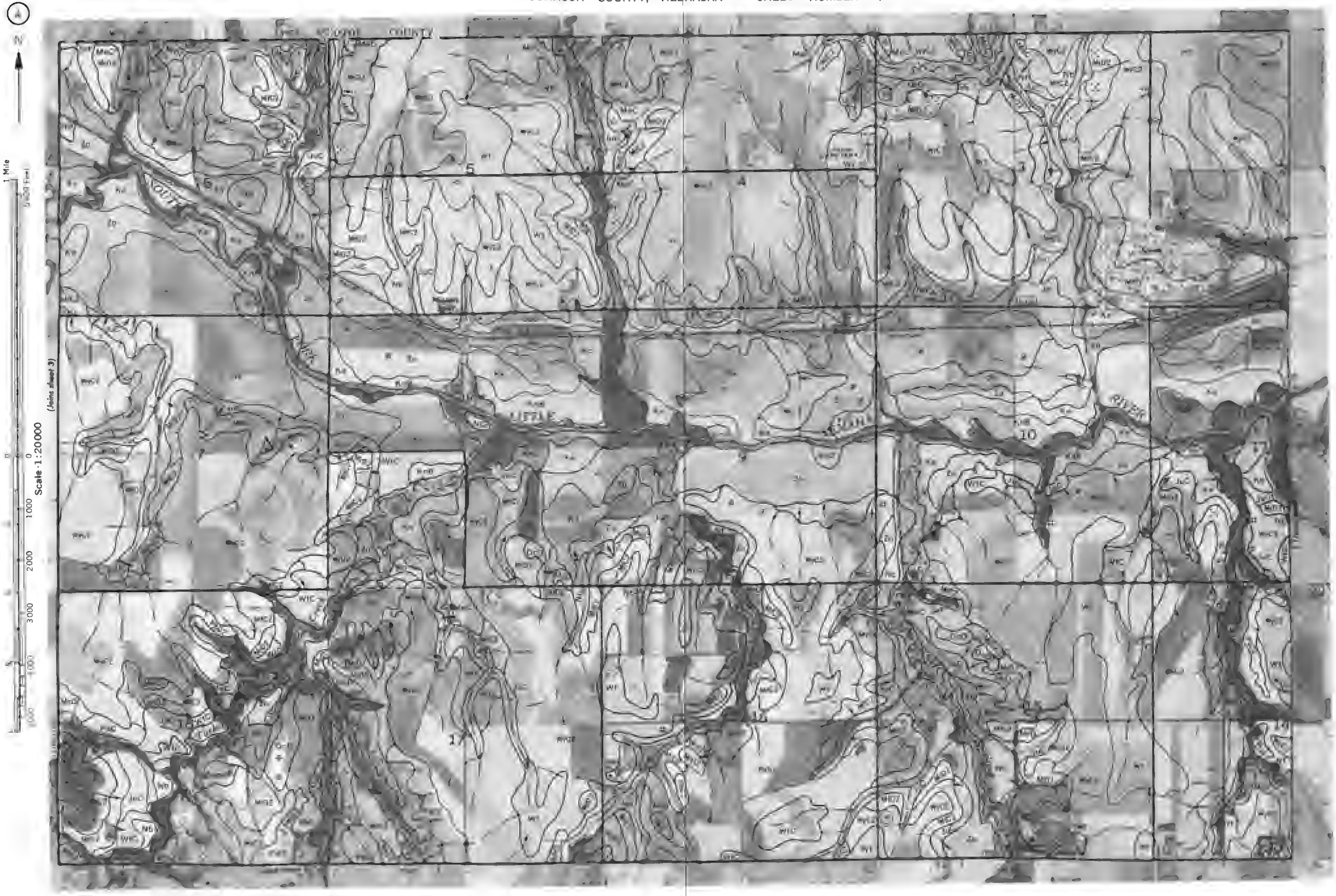
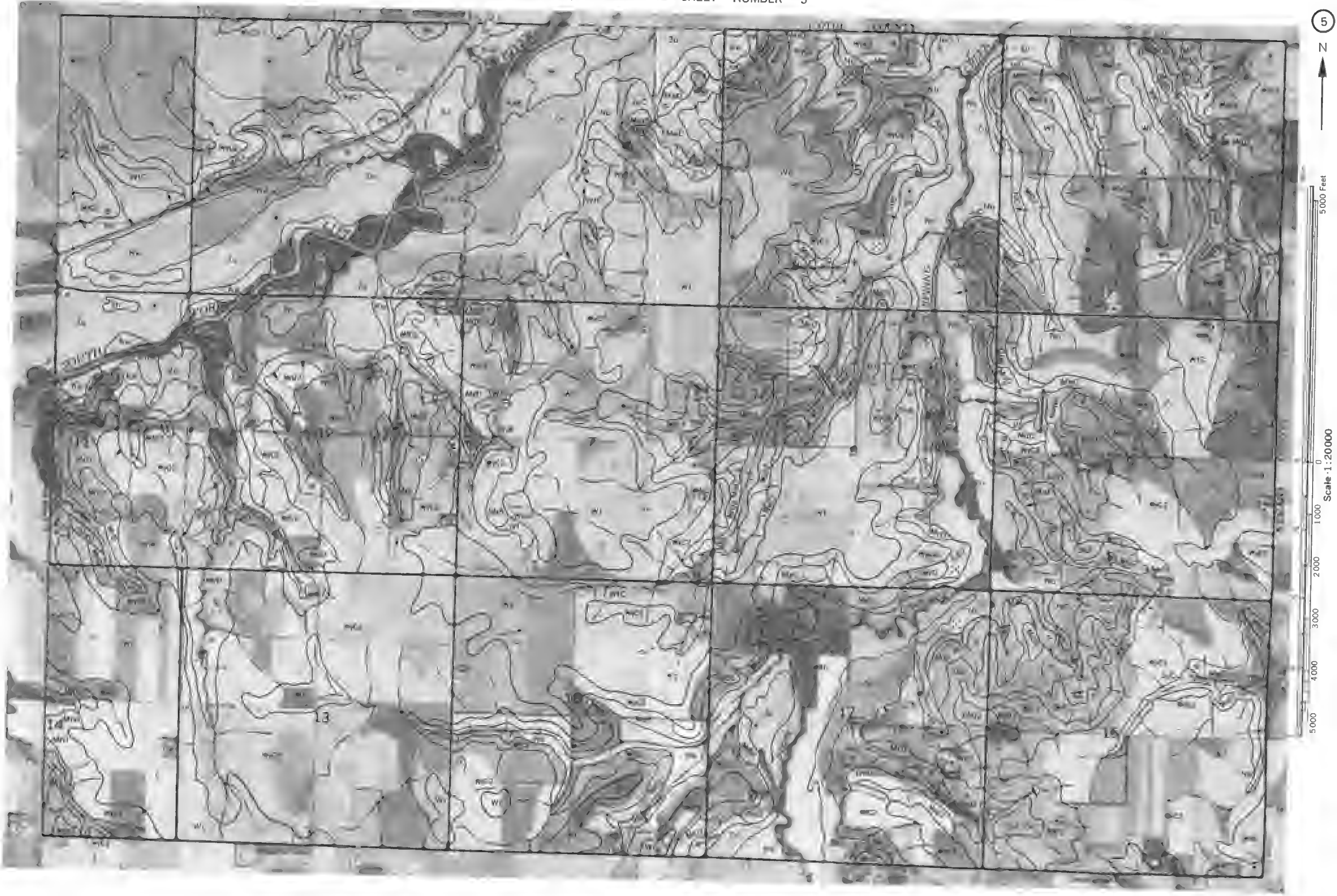
JOHNSON COUNTY, NEBRASKA — SHEET NUMBER 4





JOHNSON COUNTY, NEBRASKA NO. 5

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This map is compiled on 1974 aerial photography by the U. S. Departme
Coord nate grid ticks and land d vision corne
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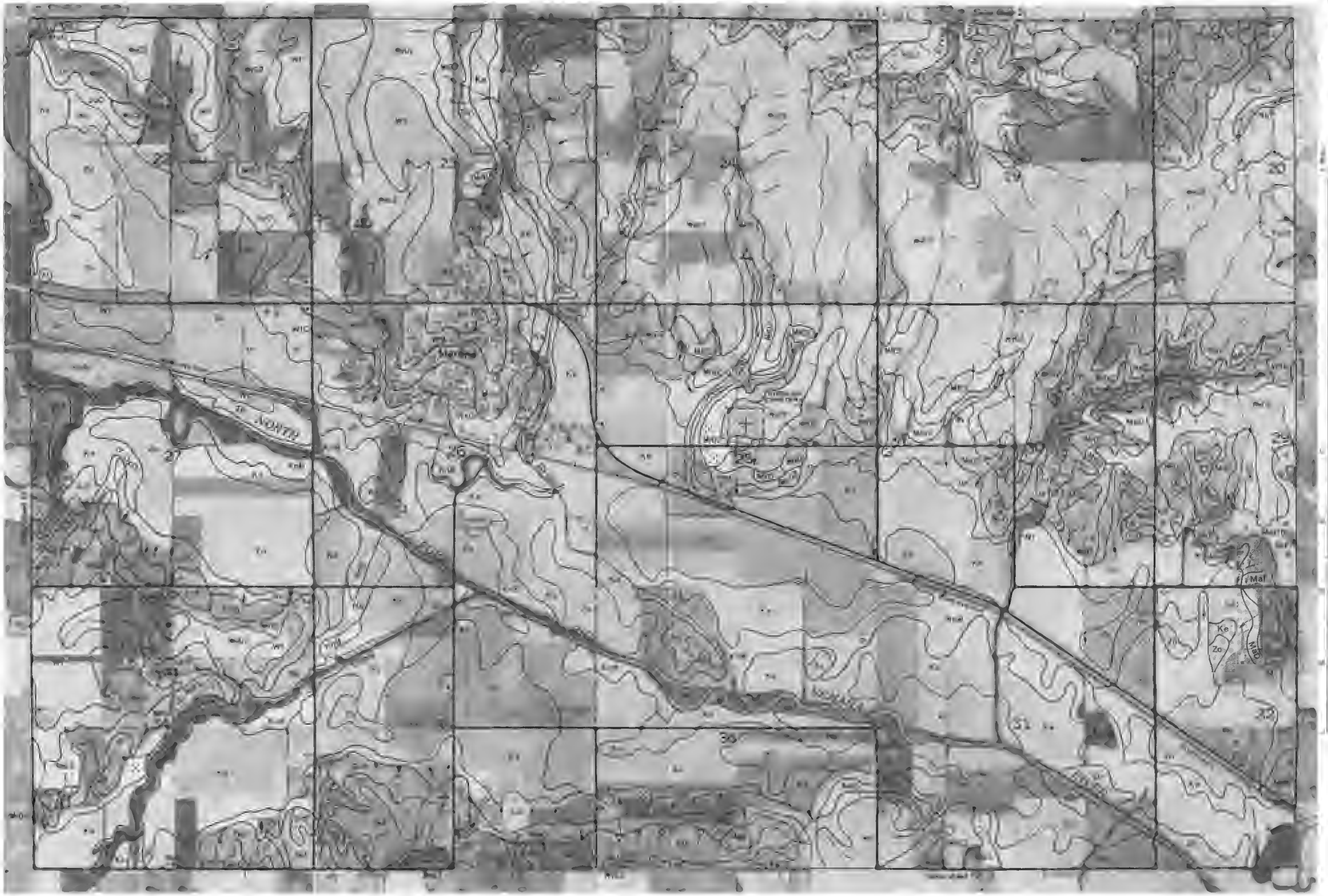

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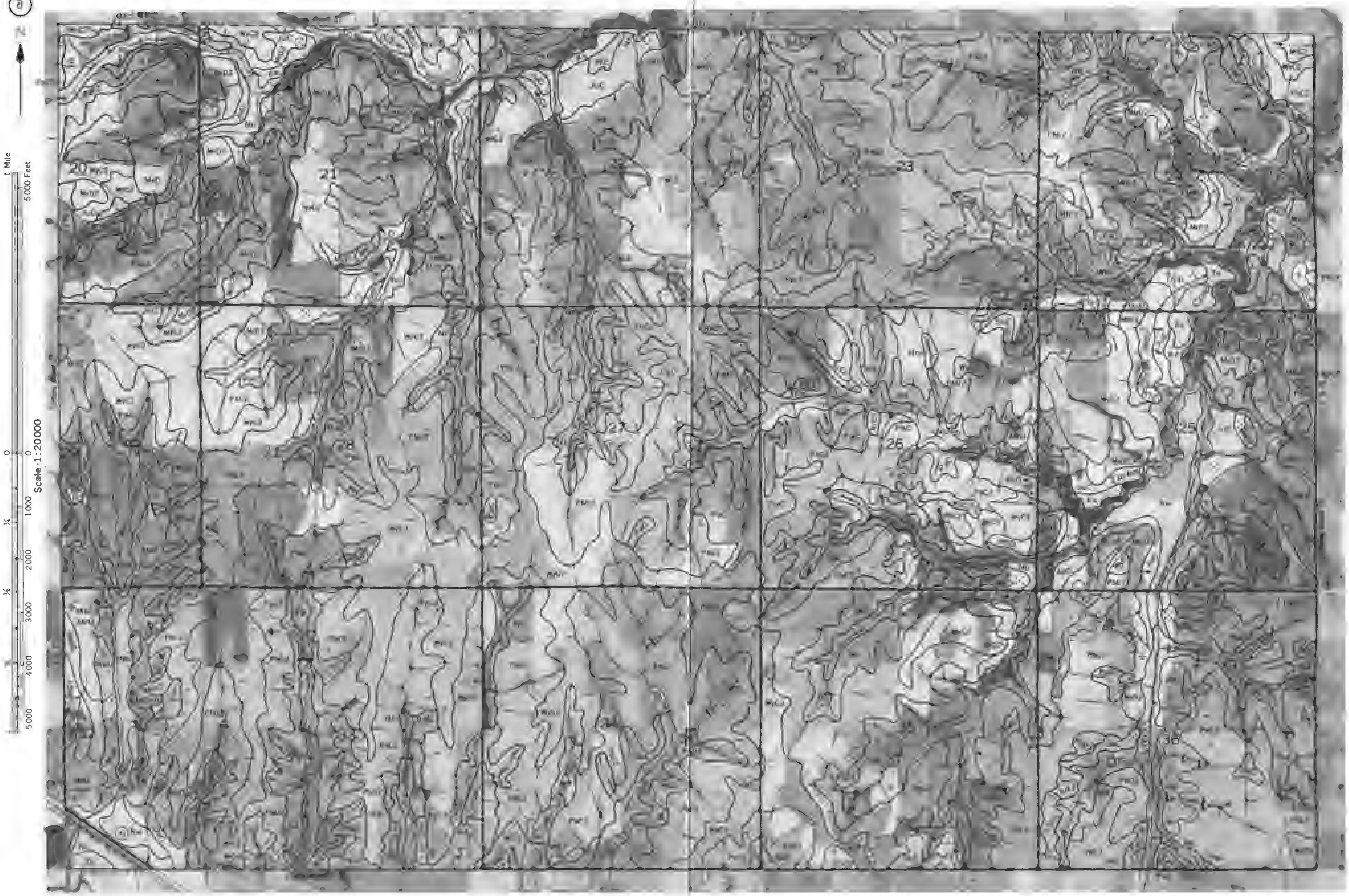
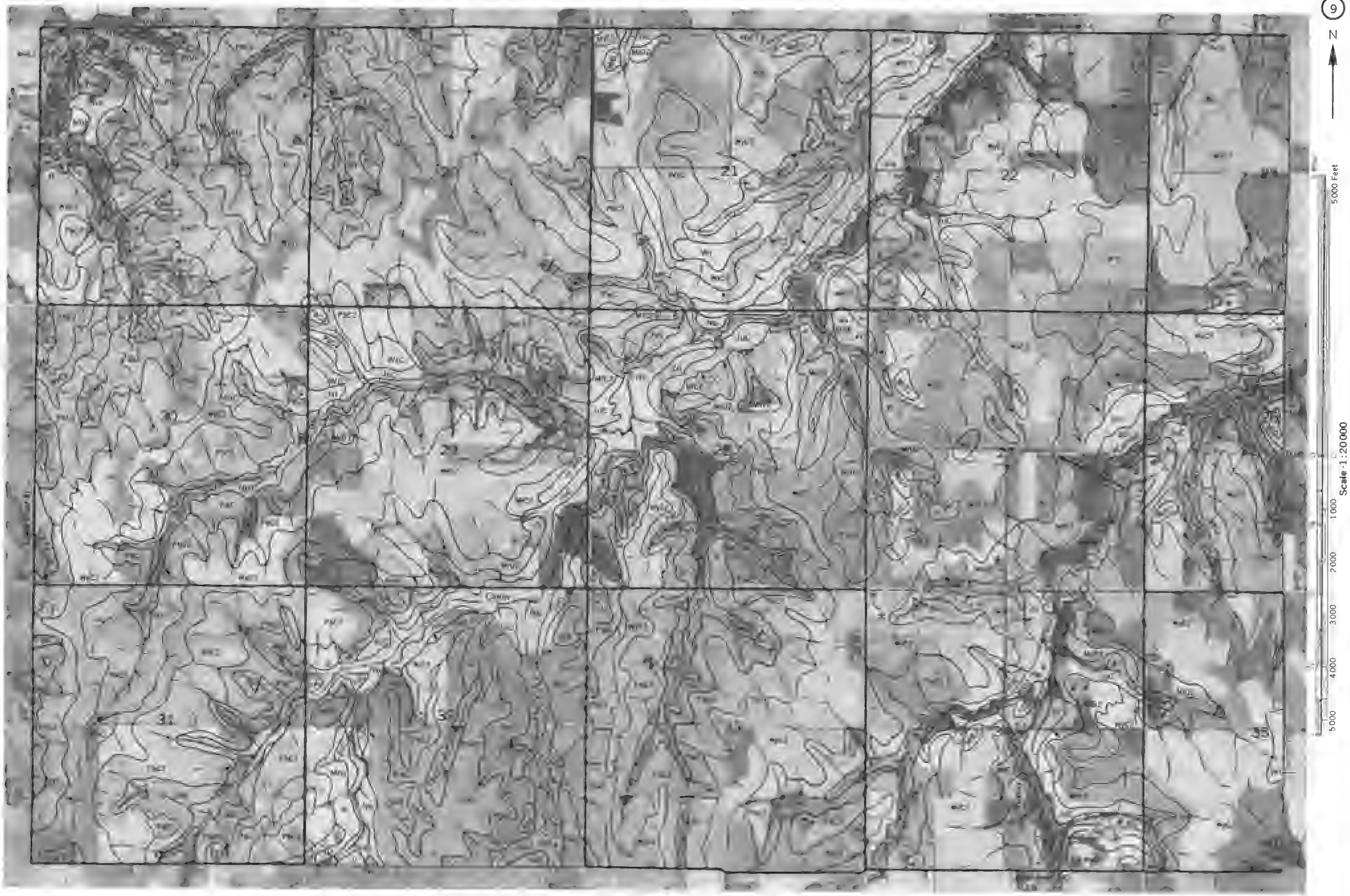
Scale 1:20000

JOHNSON COUNTY, NEBRASKA — SHEET NUMBER 8

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JOHNSON COUNTY, NEBRASKA — SHEET NUMBER 10

(10)

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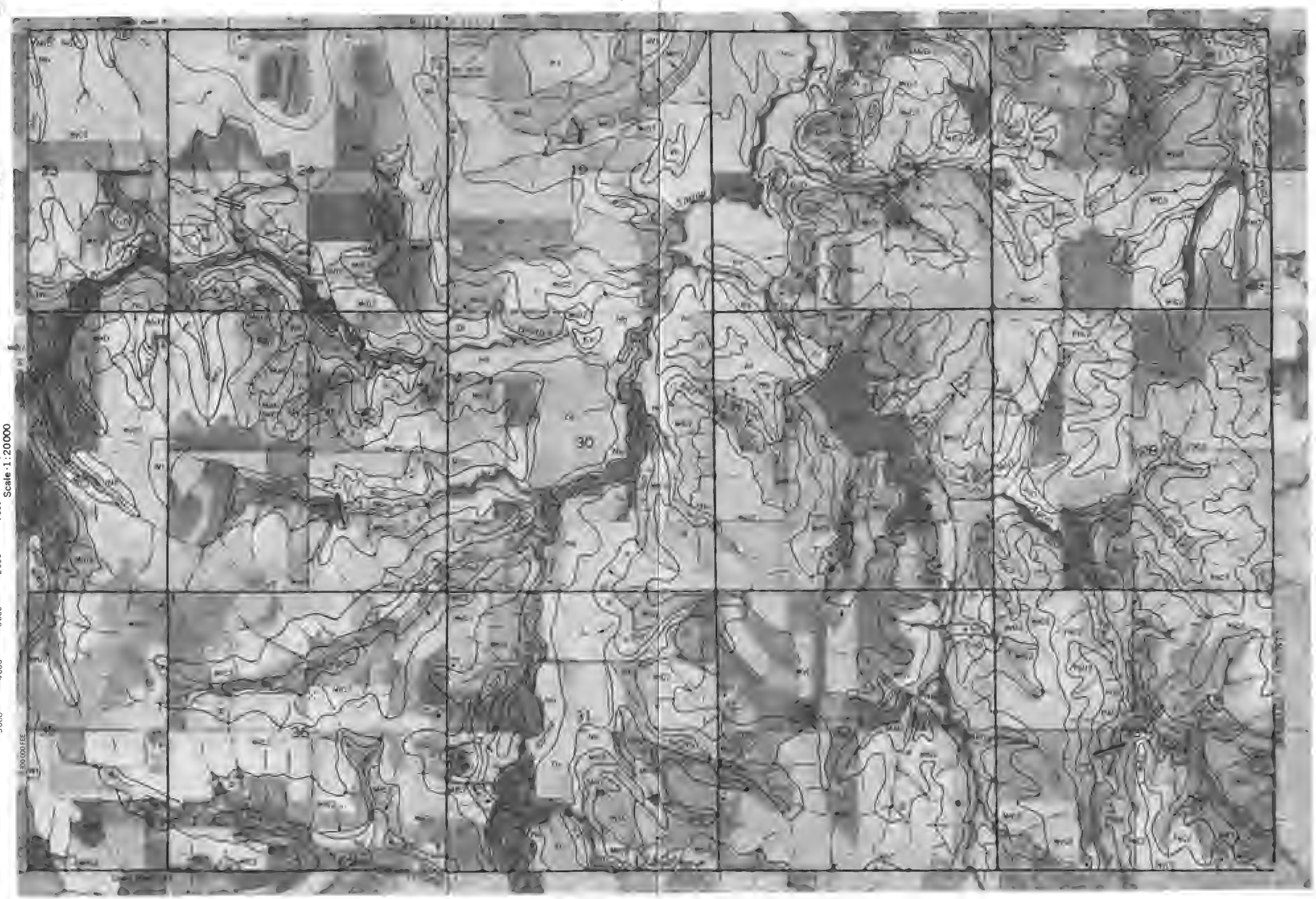

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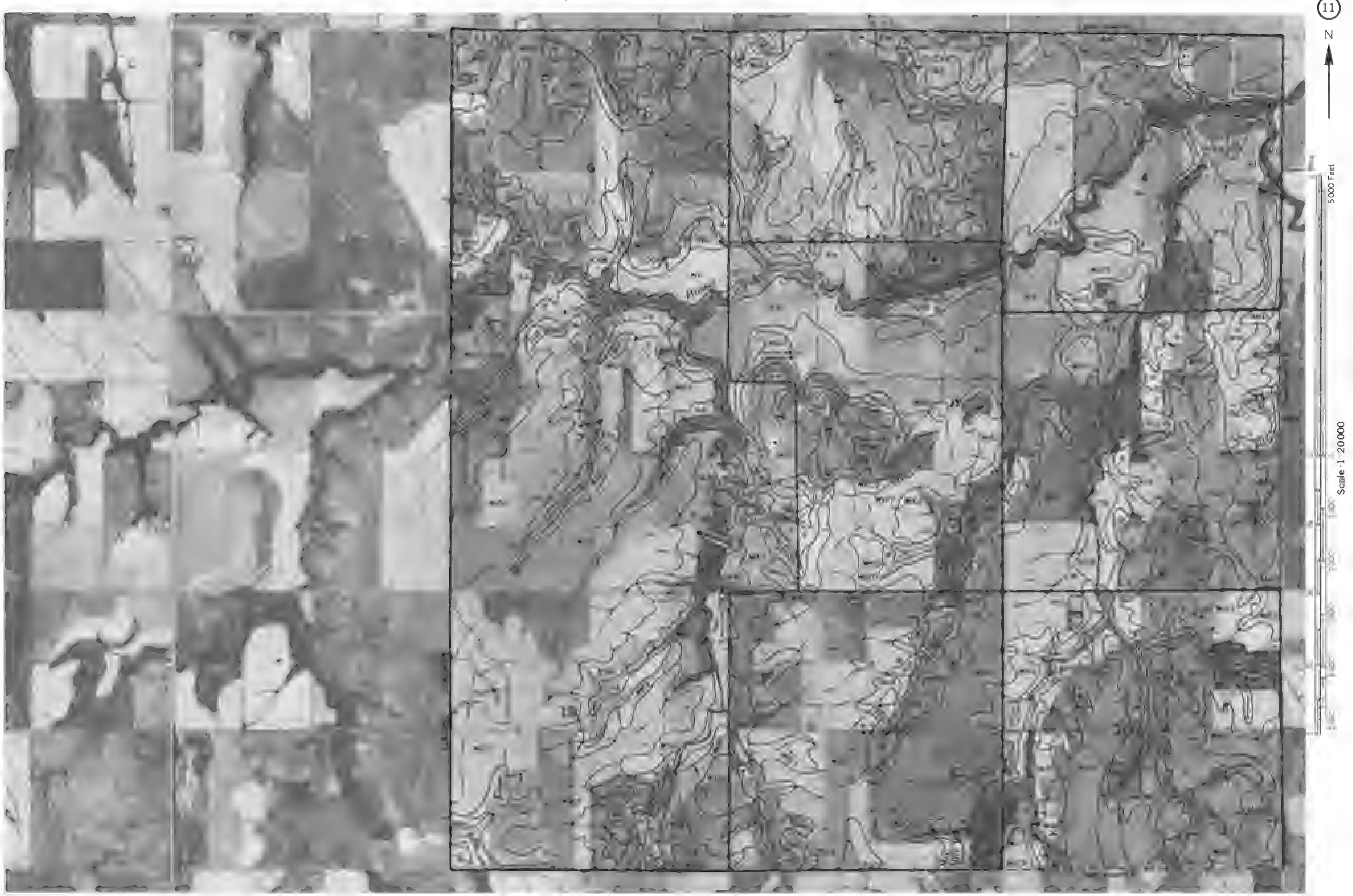
JOHNSON COUNTY, NEBRASKA — SHEET NUMBER 11



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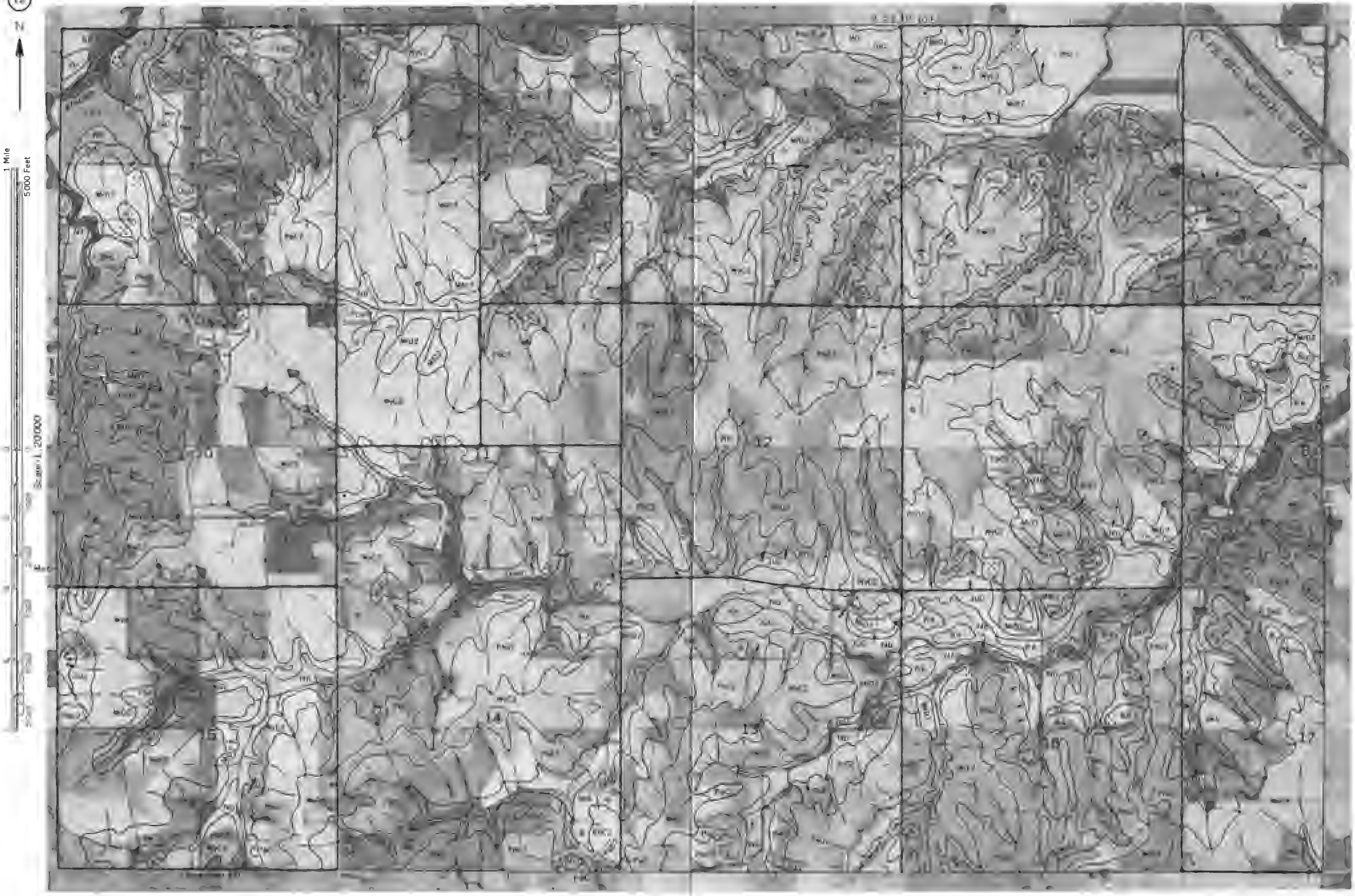

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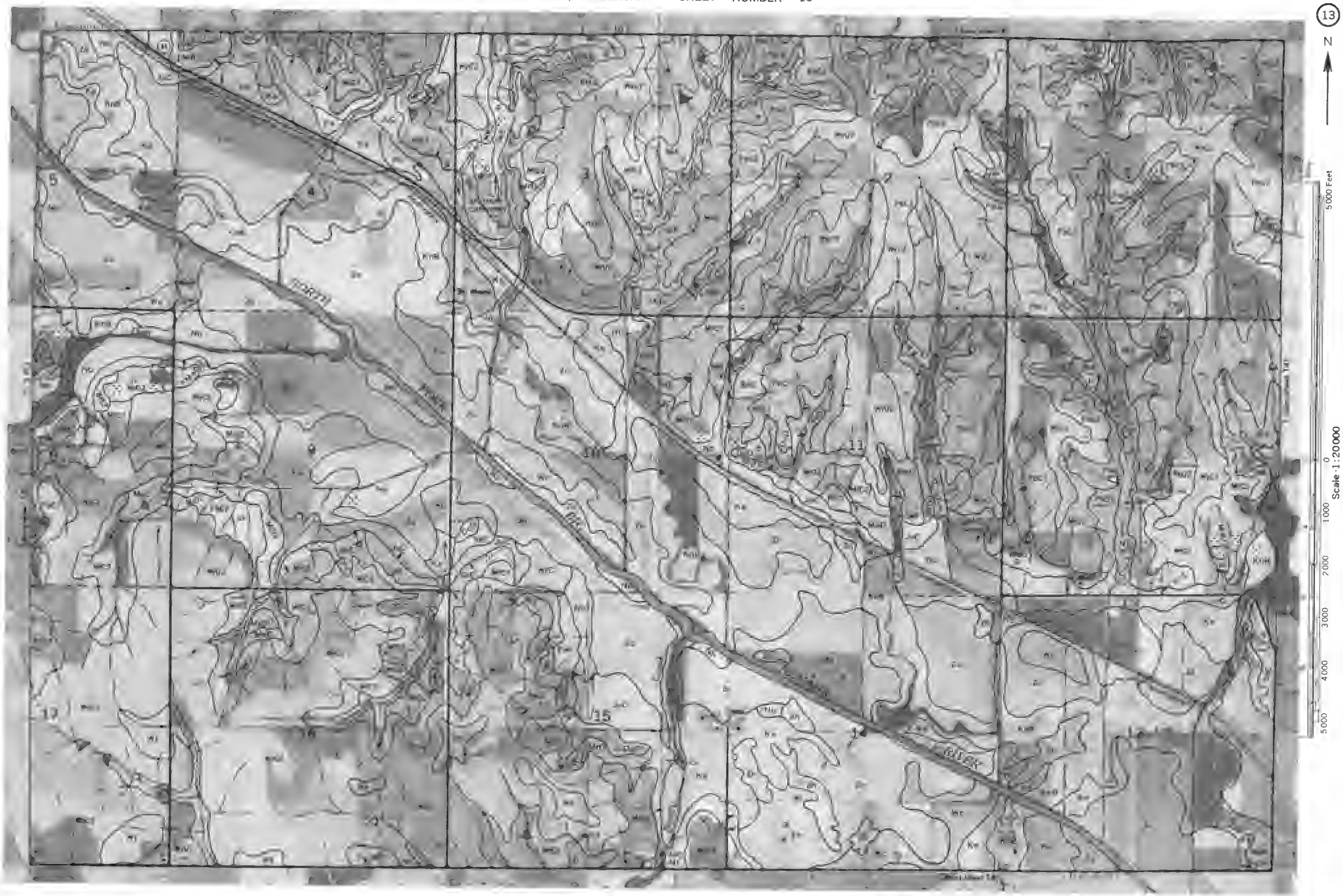

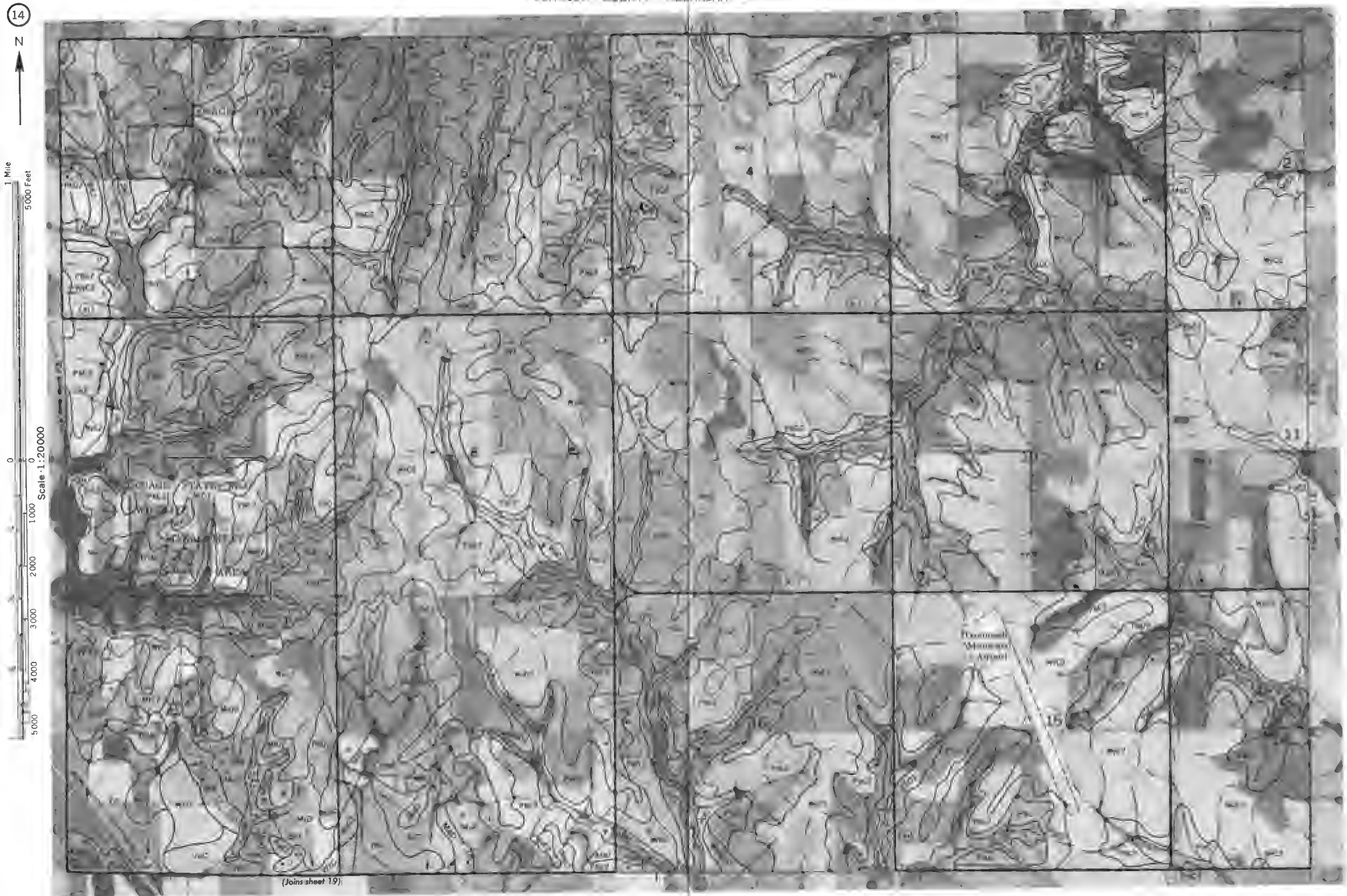
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(Joins sheet 19)

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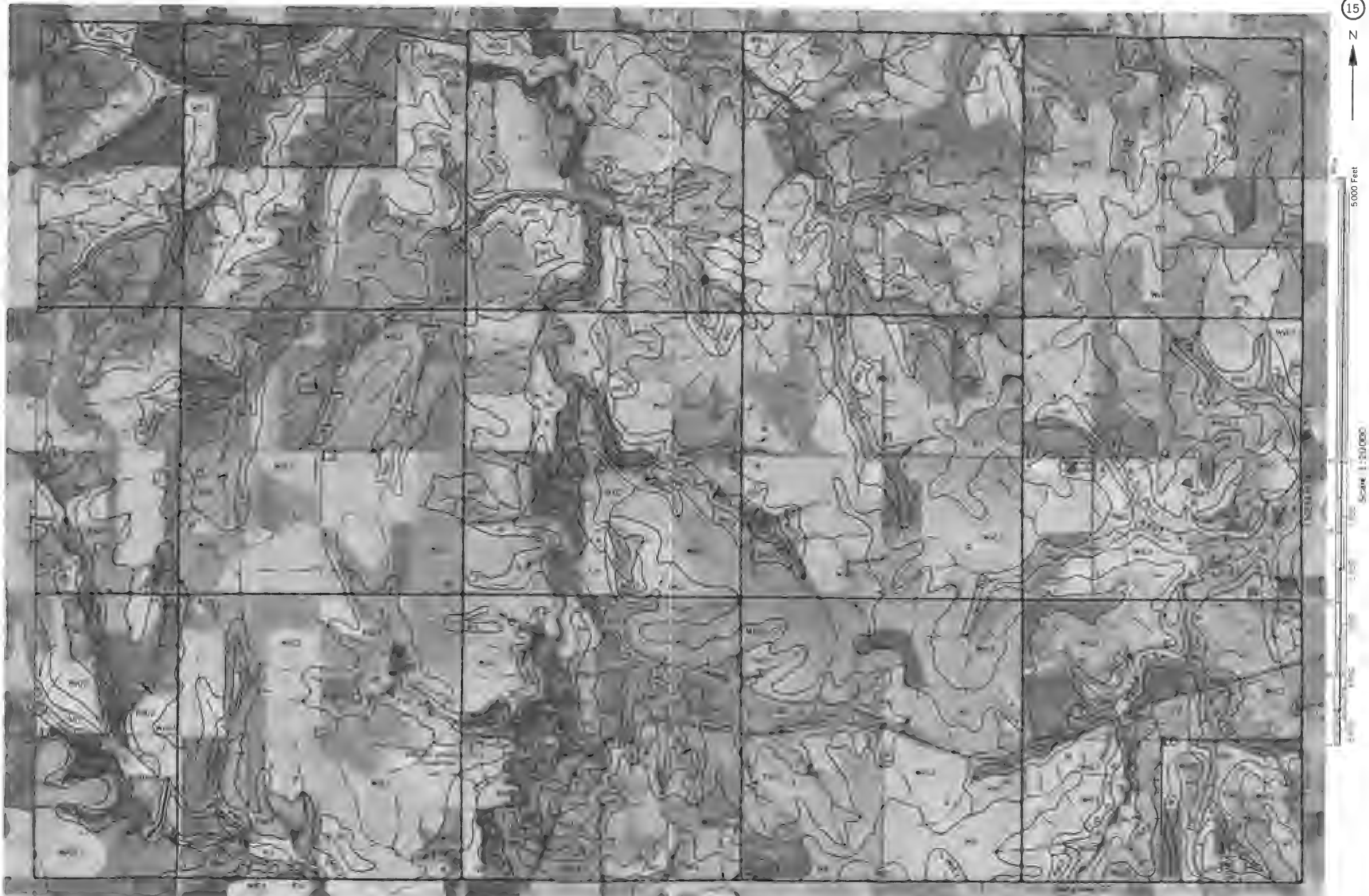

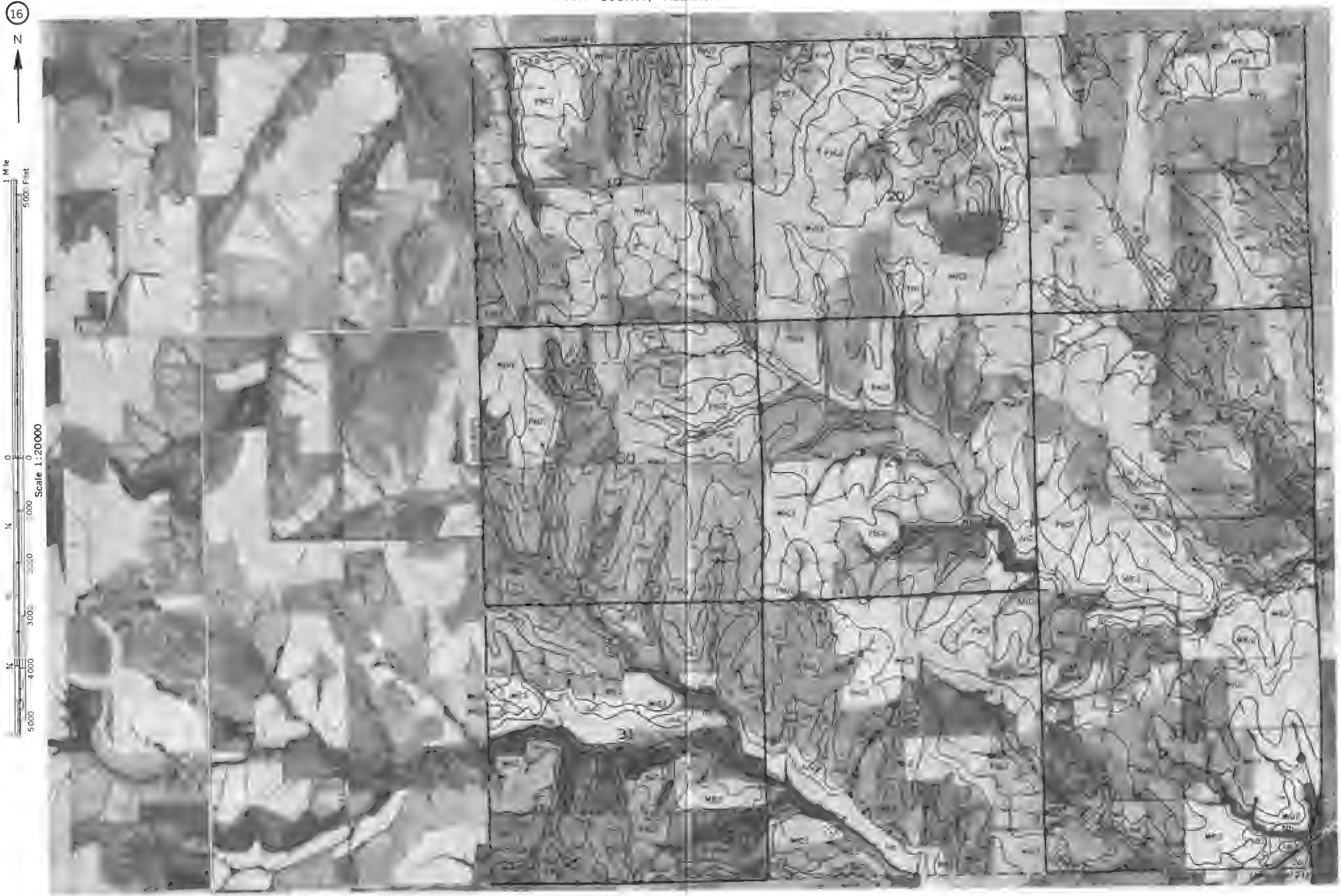
16
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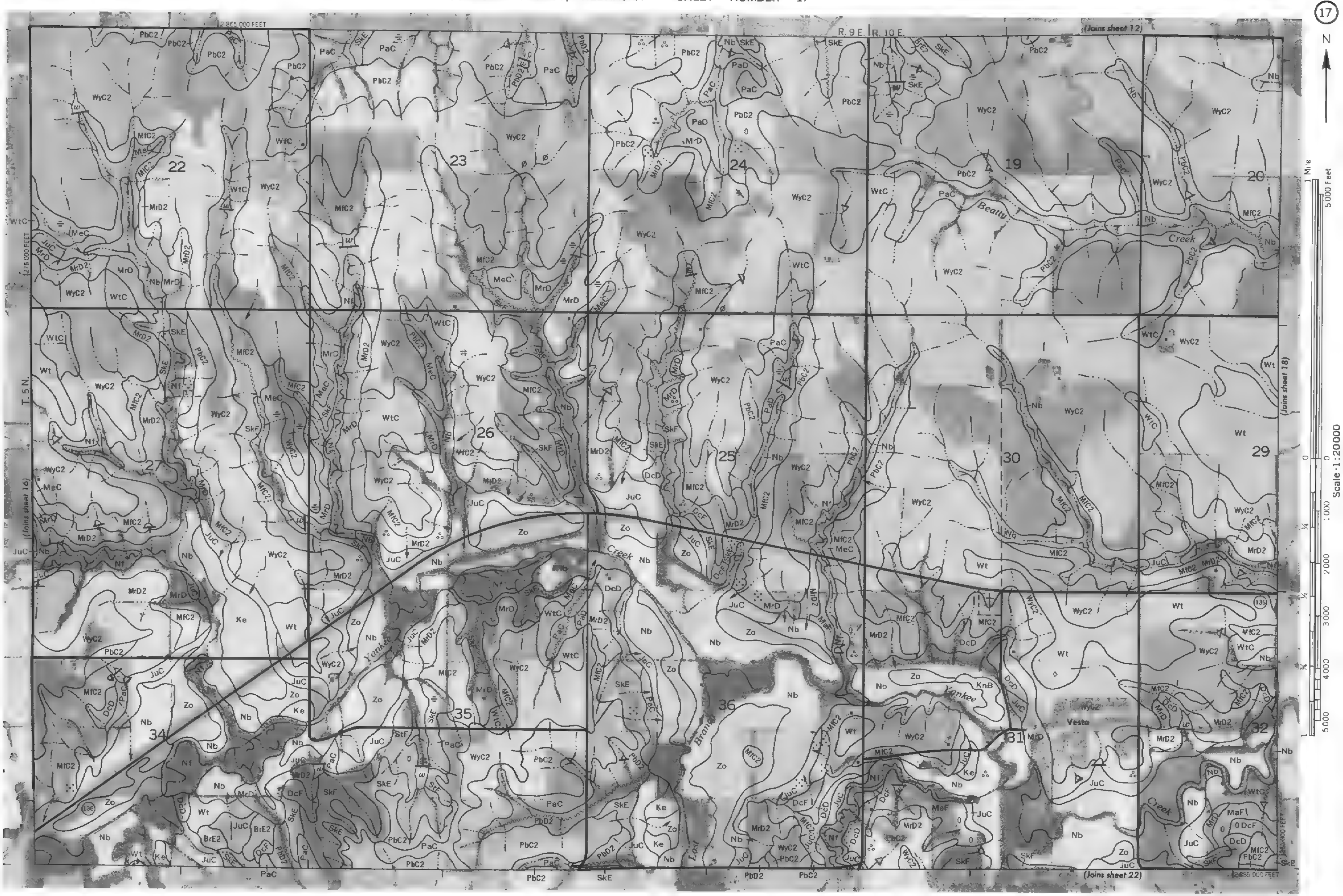
31



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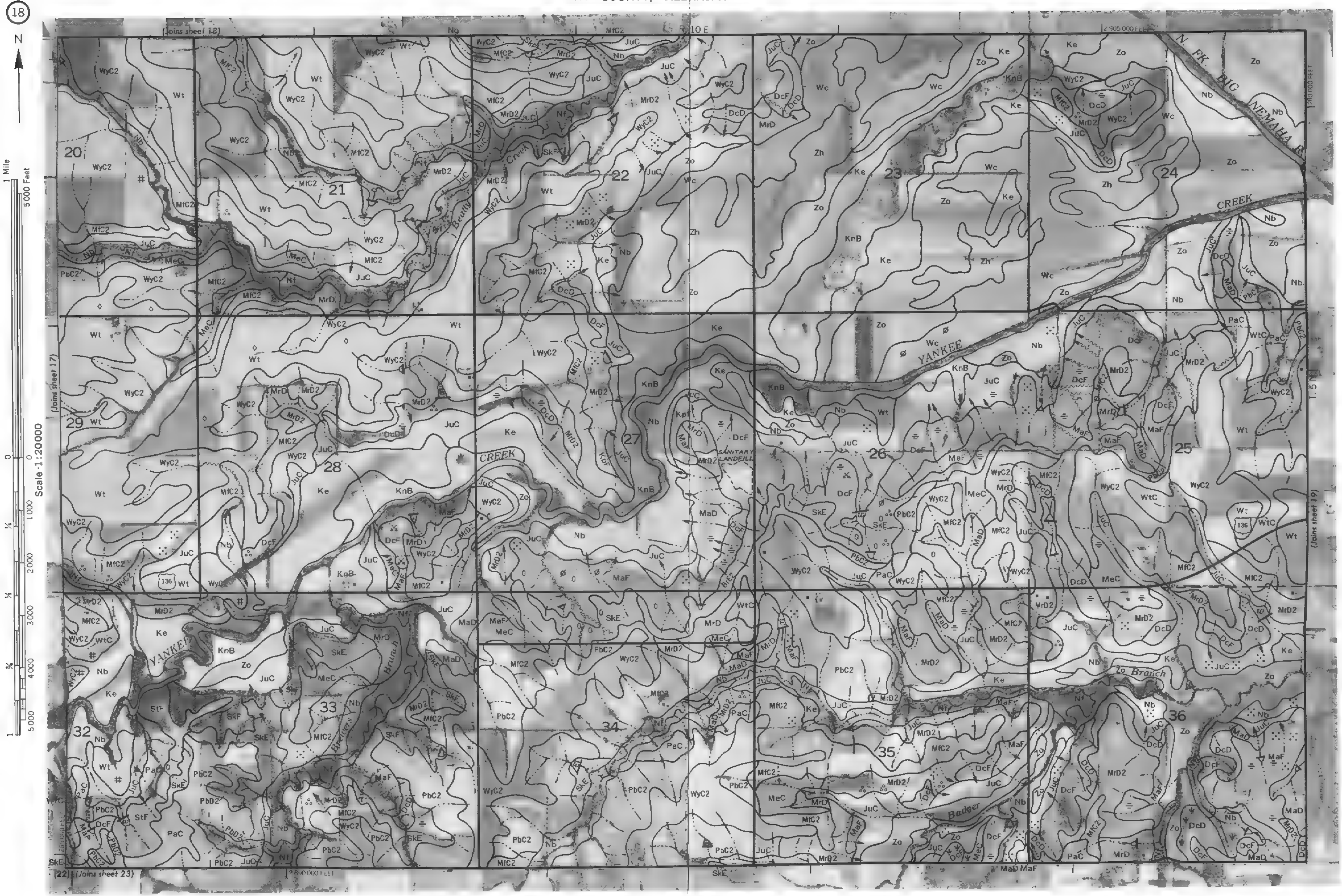

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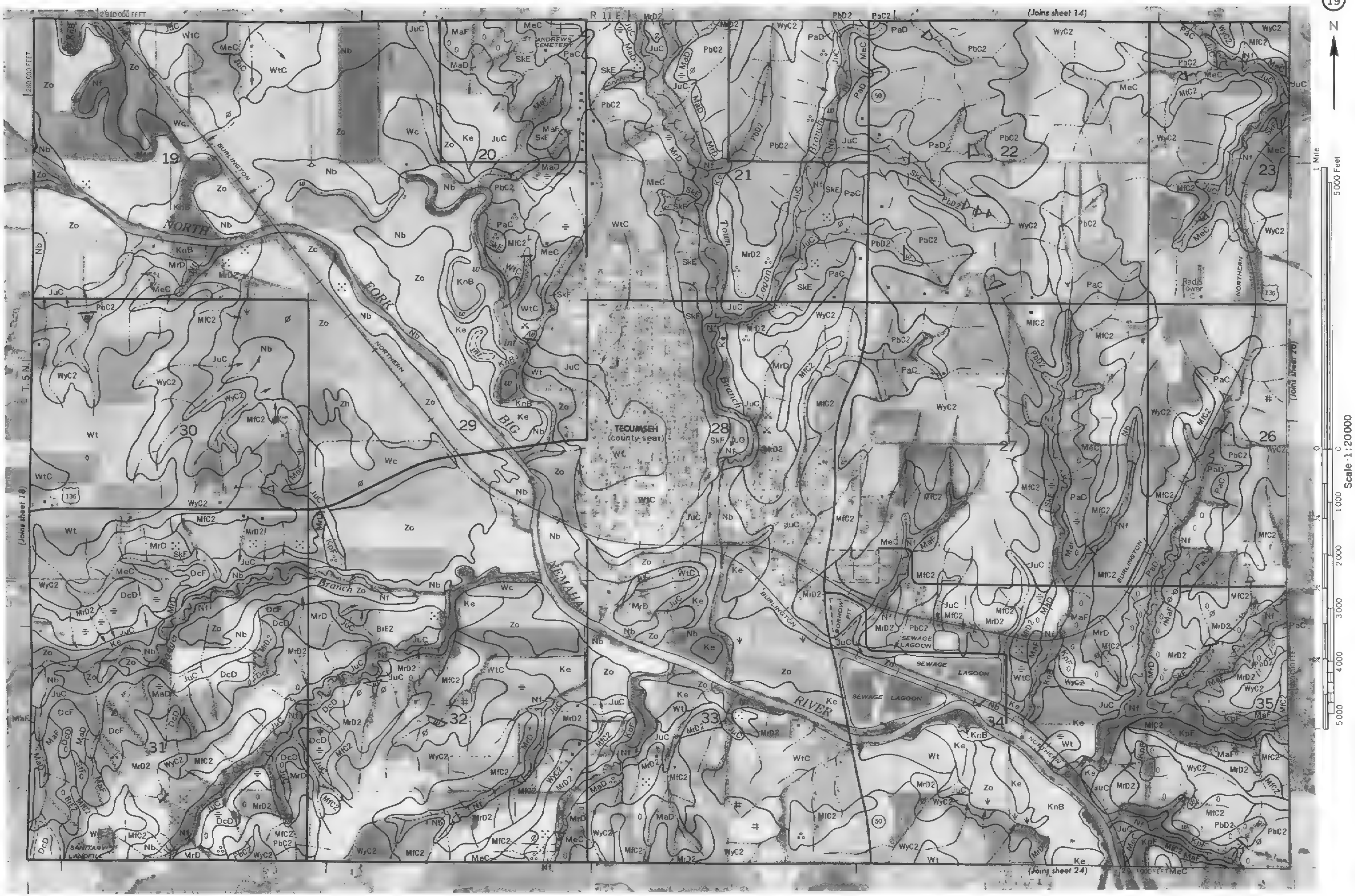

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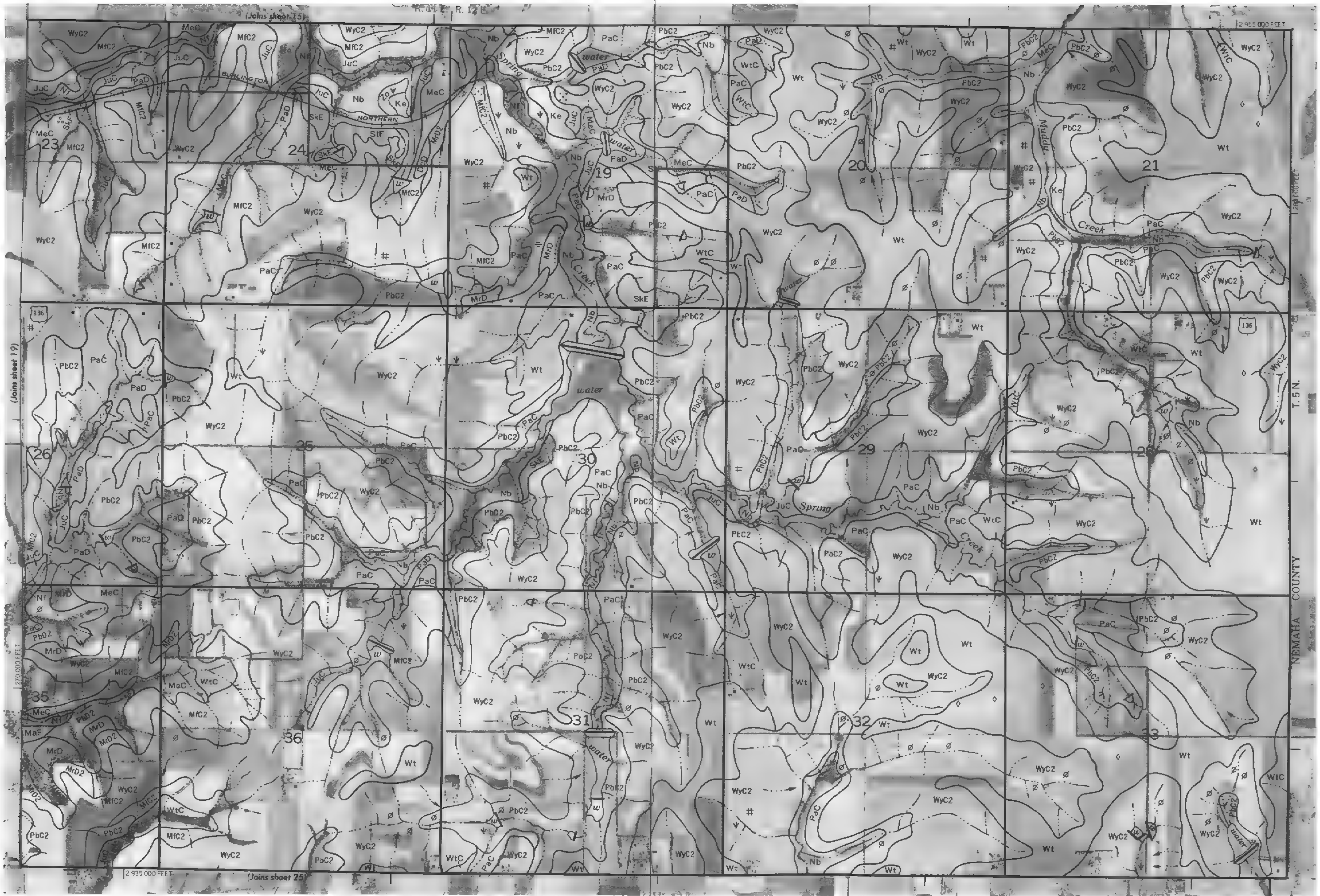

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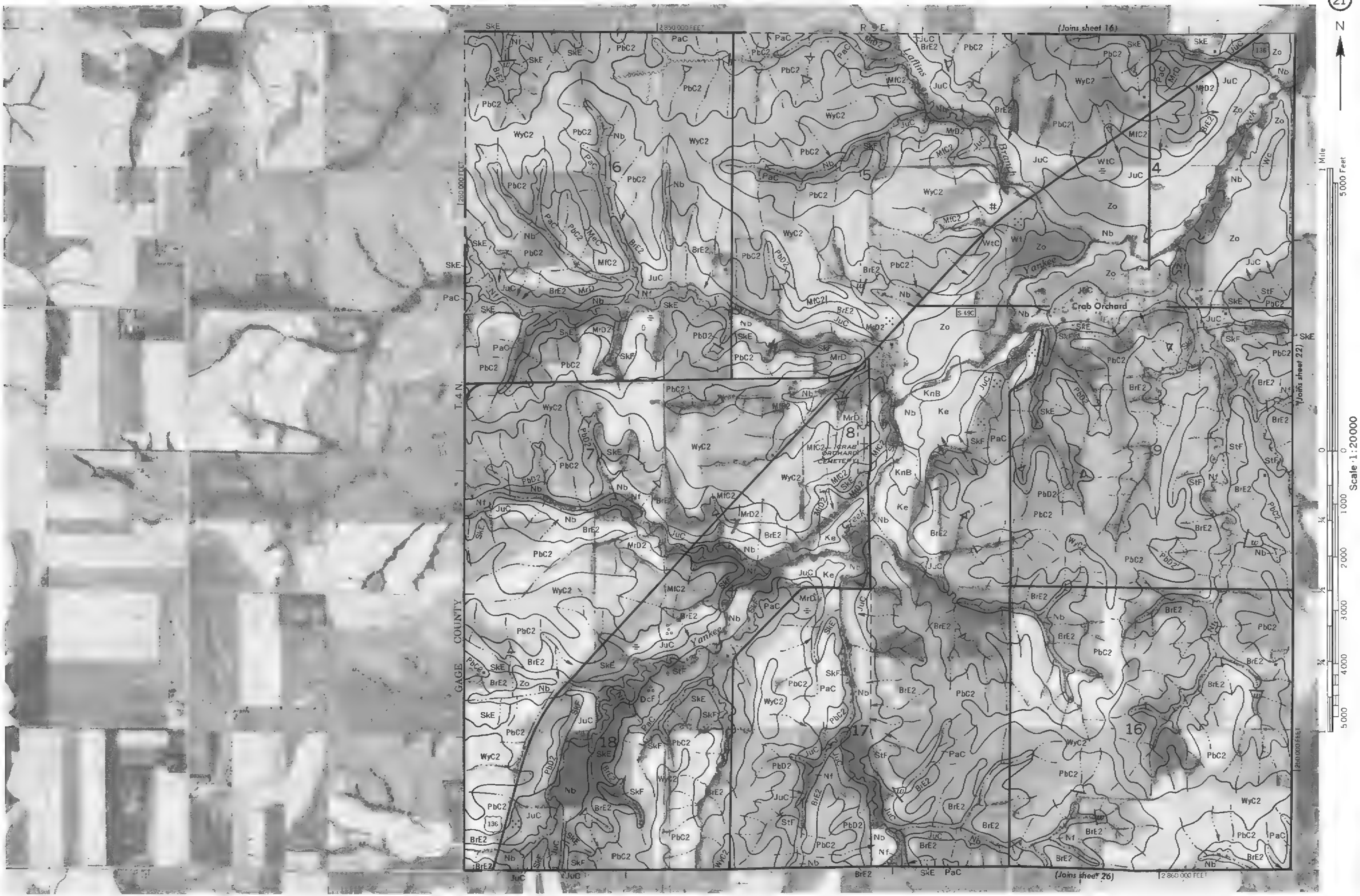
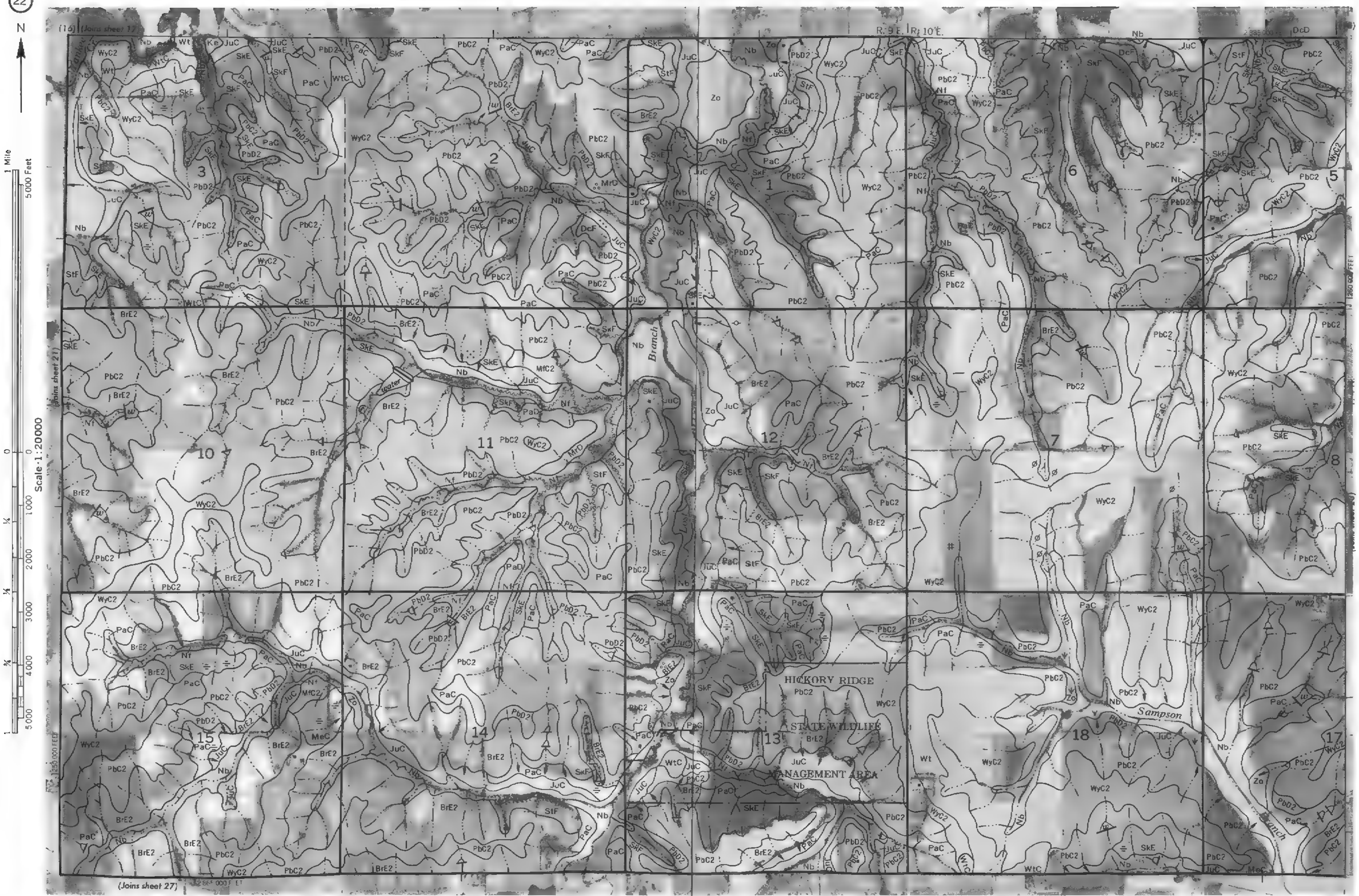

N
(Joins sheet 16)
(Joins sheet 22)
(Joins sheet 26)
R. 9 E.
T. 4 N.
GAGE COUNTY
Crab Orchard
CRAB ORCHARD CEMETERY
Laflins Branch
Yankee Creek
Scale 1:20000
1 Mile
5000 Feet



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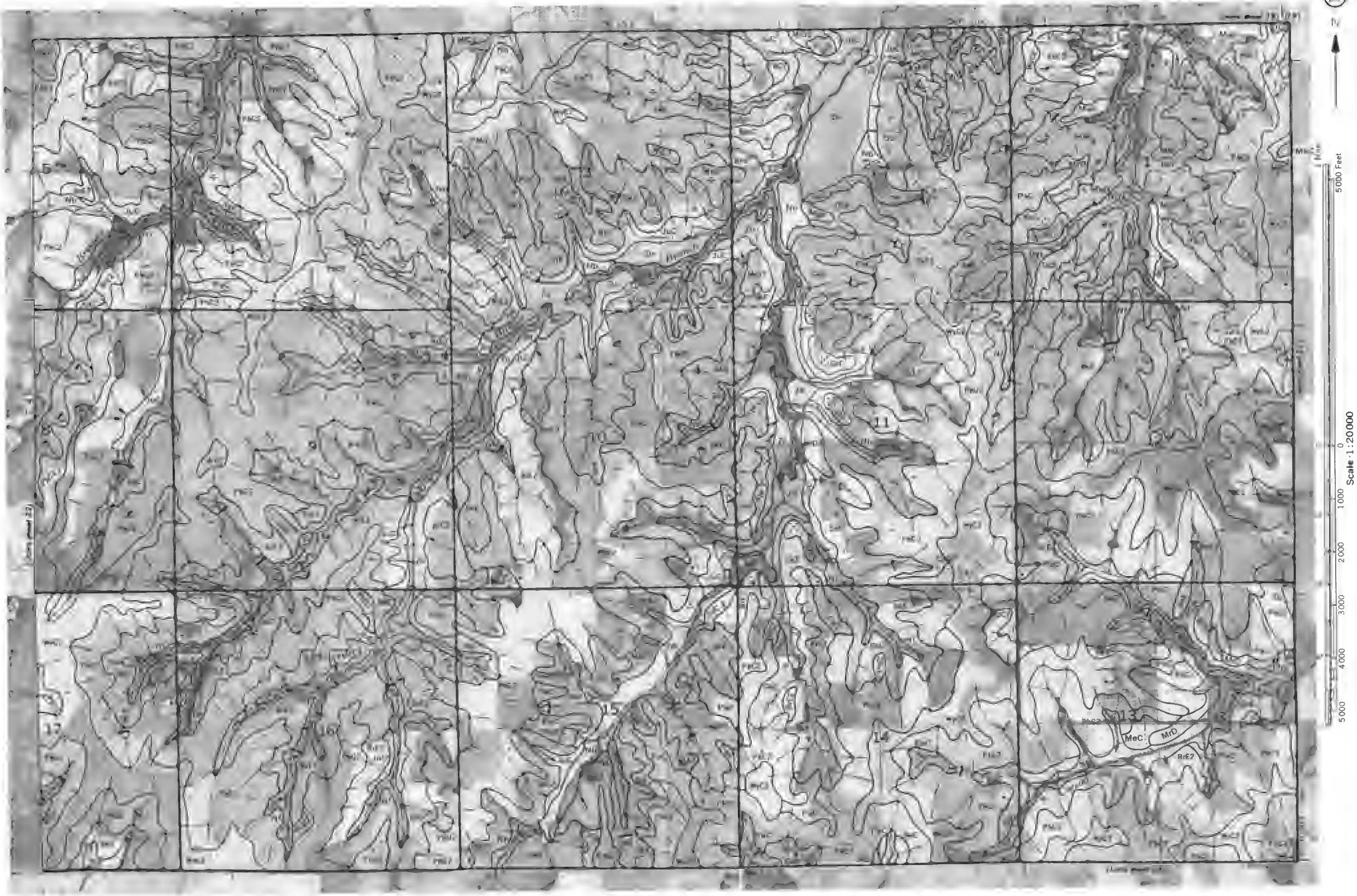

23
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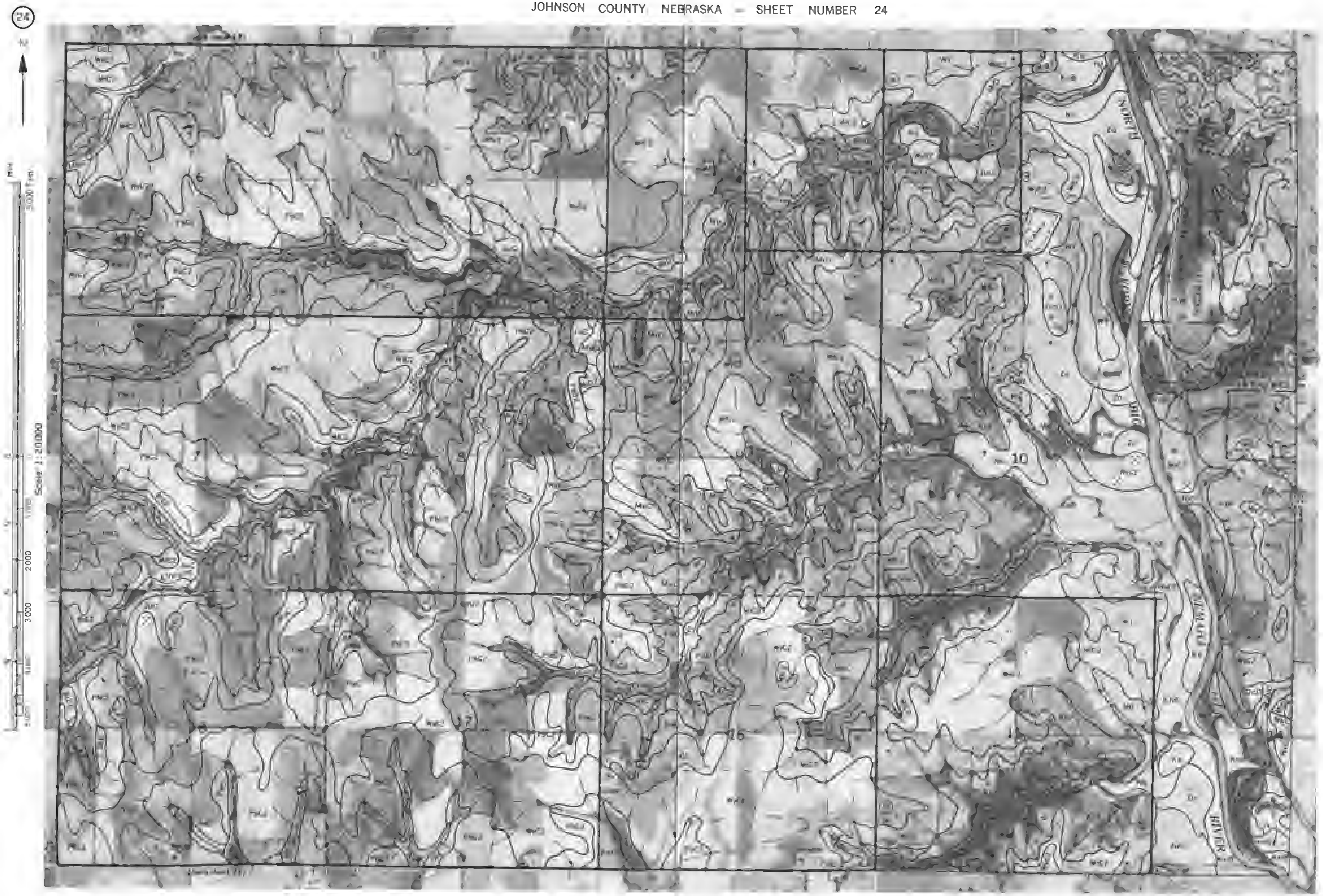
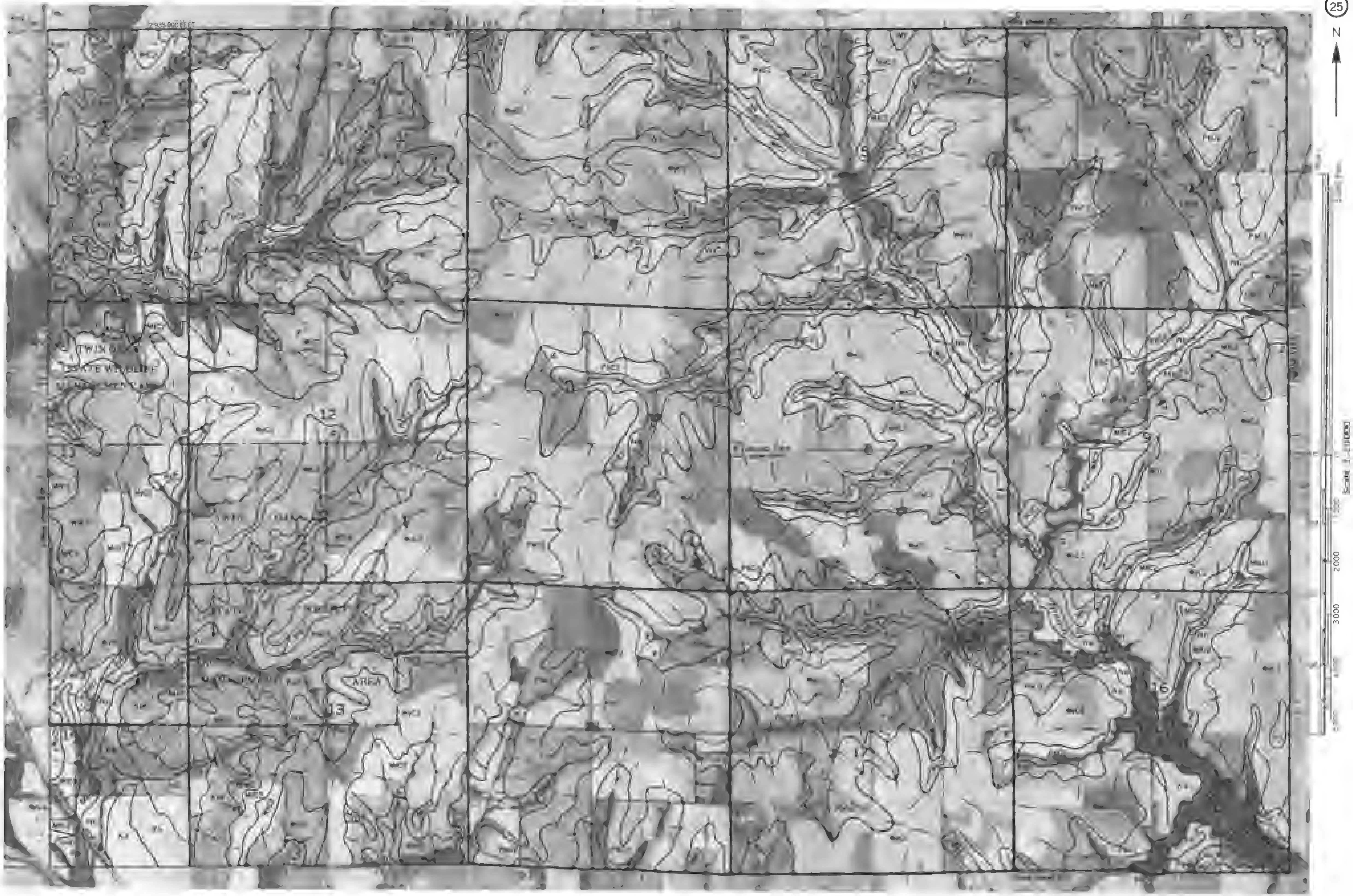
JOHNSON COUNTY NEBRASKA — SHEET NUMBER 24



This map is compiled on ... ce and cooperating agencies

JOHNSON COUNTY, NEBRASKA NO. 24


25
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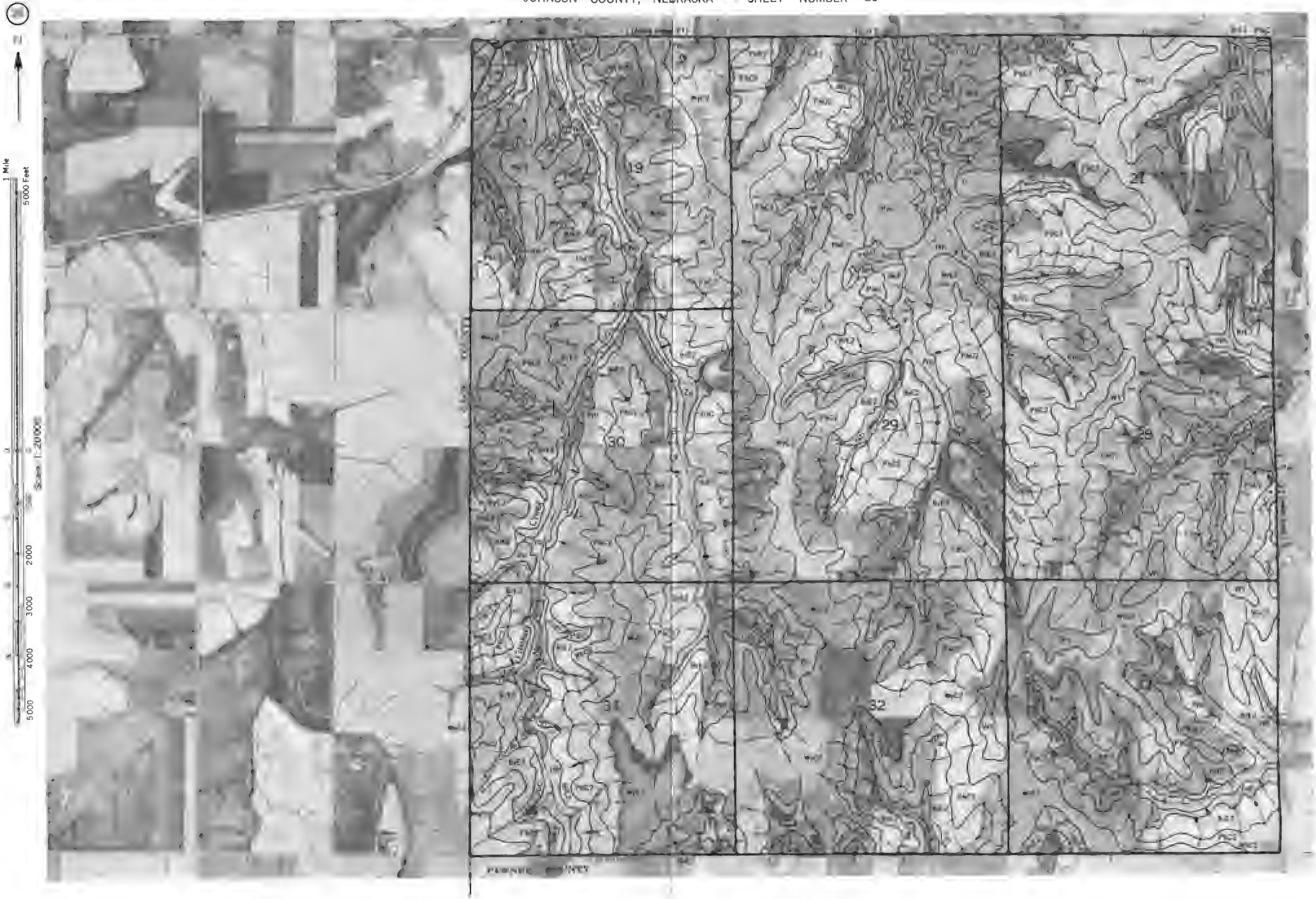
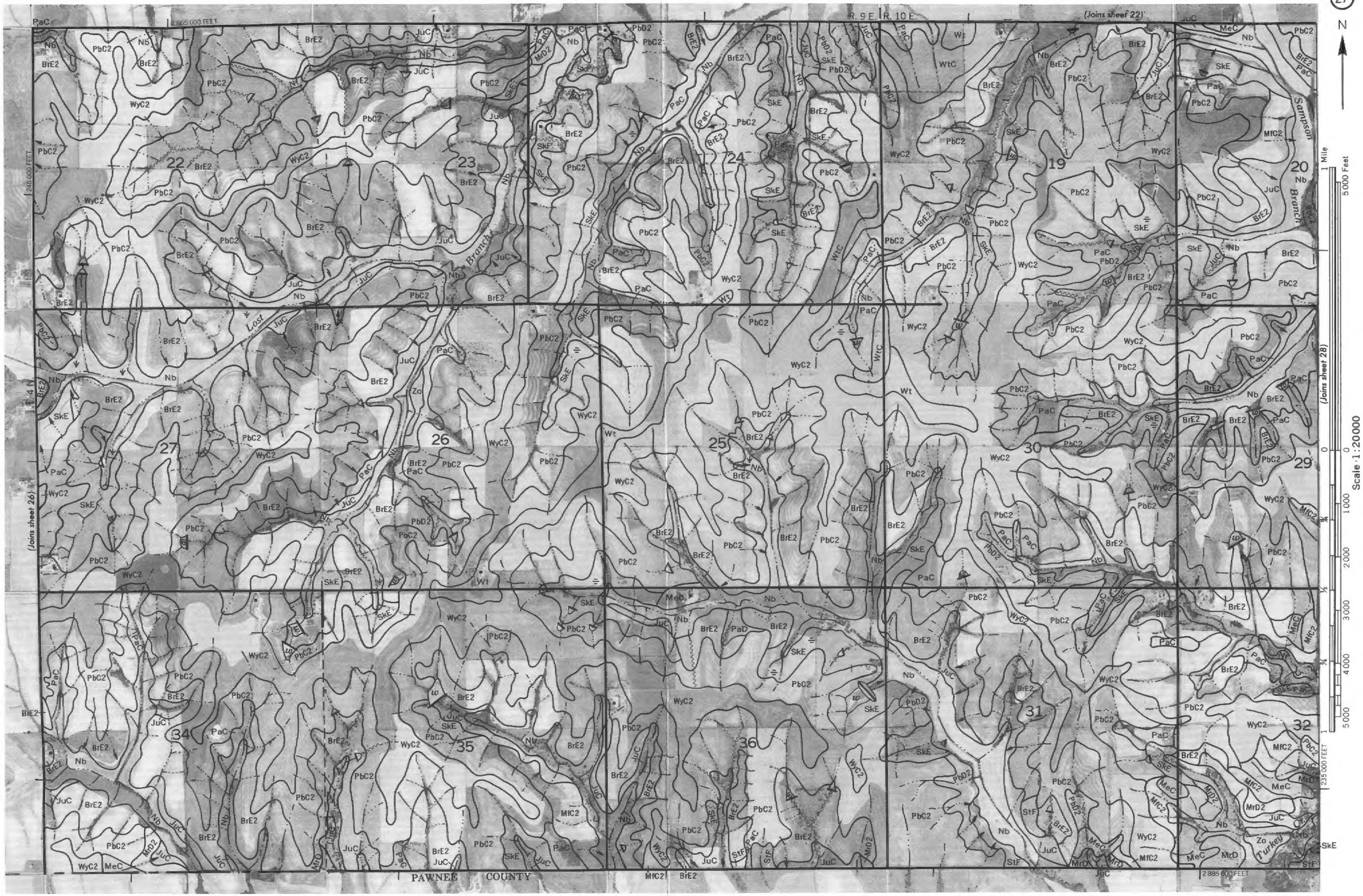
JOHNSON COUNTY, NEBRASKA — SHEET NUMBER 26





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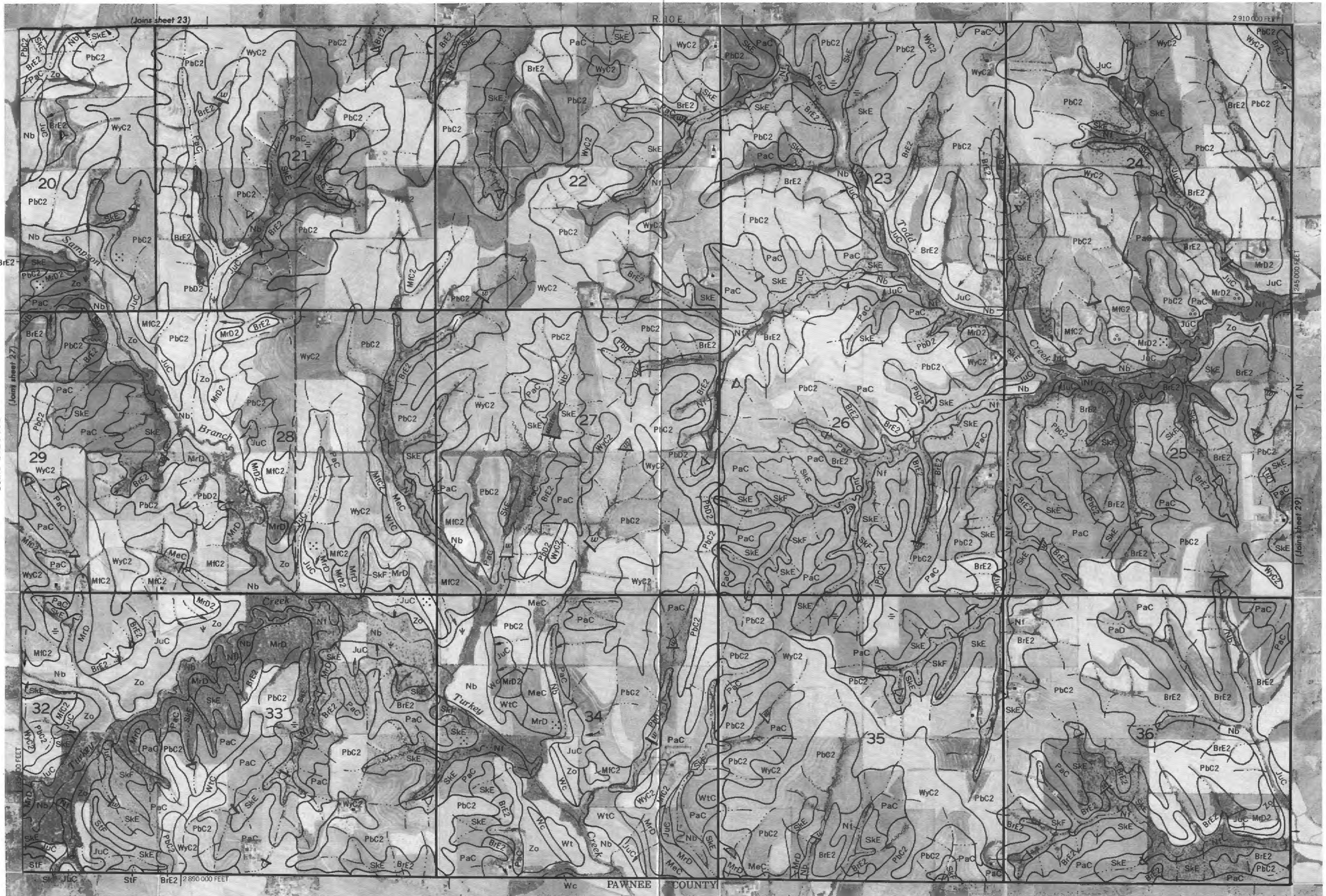
28

N

Scale 1:20000

1 Mile — 5000 Feet



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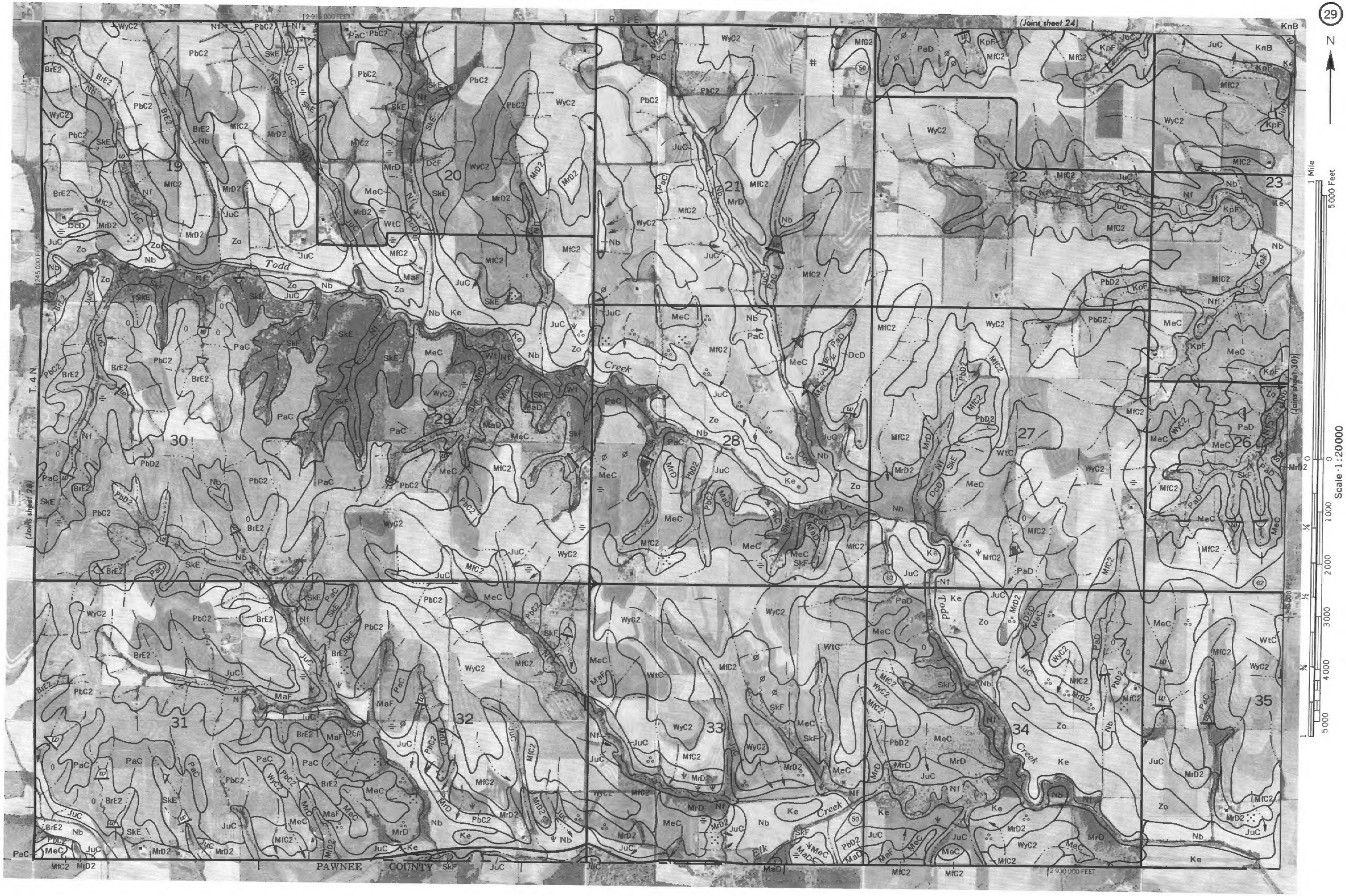
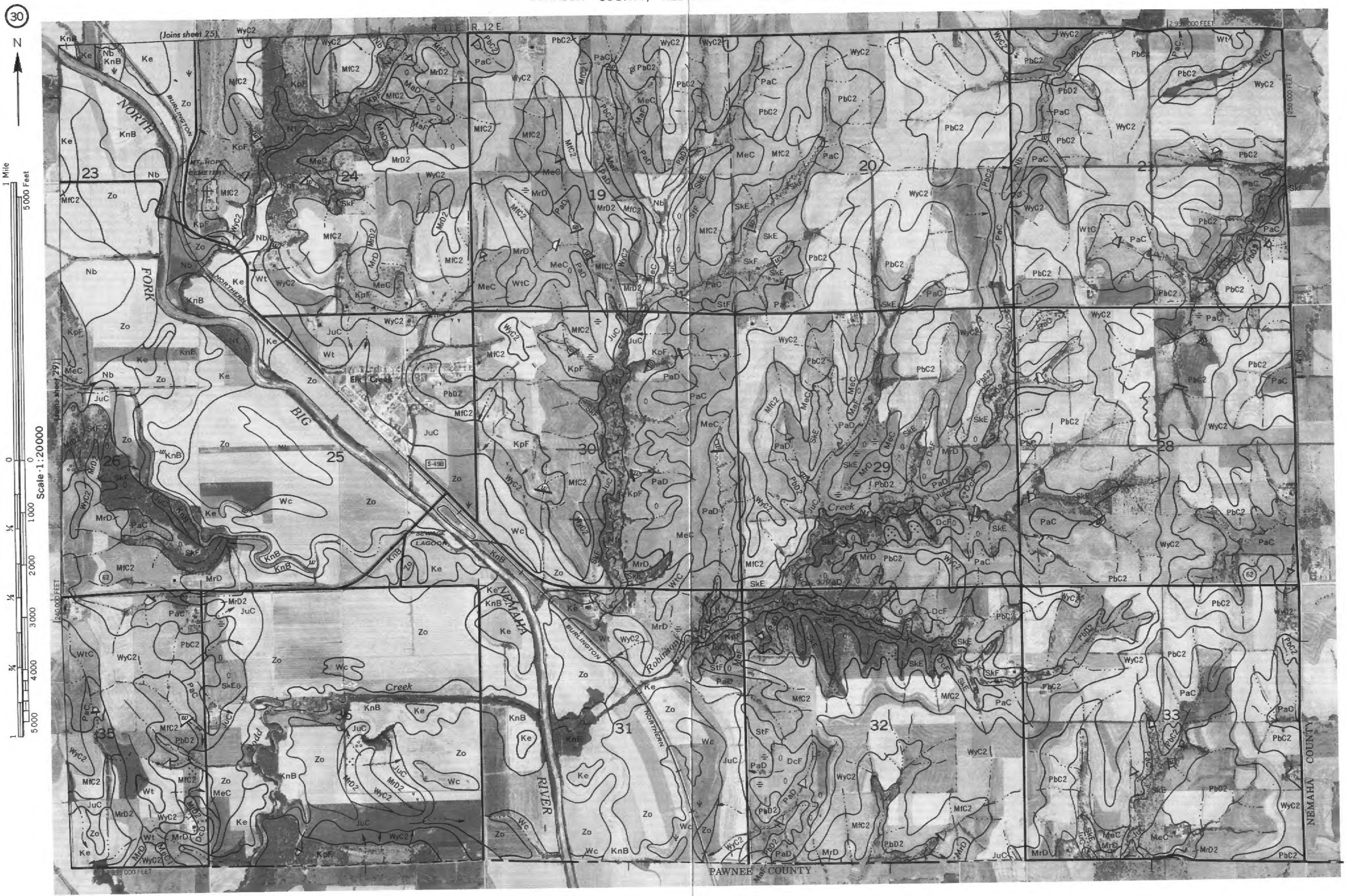


This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



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